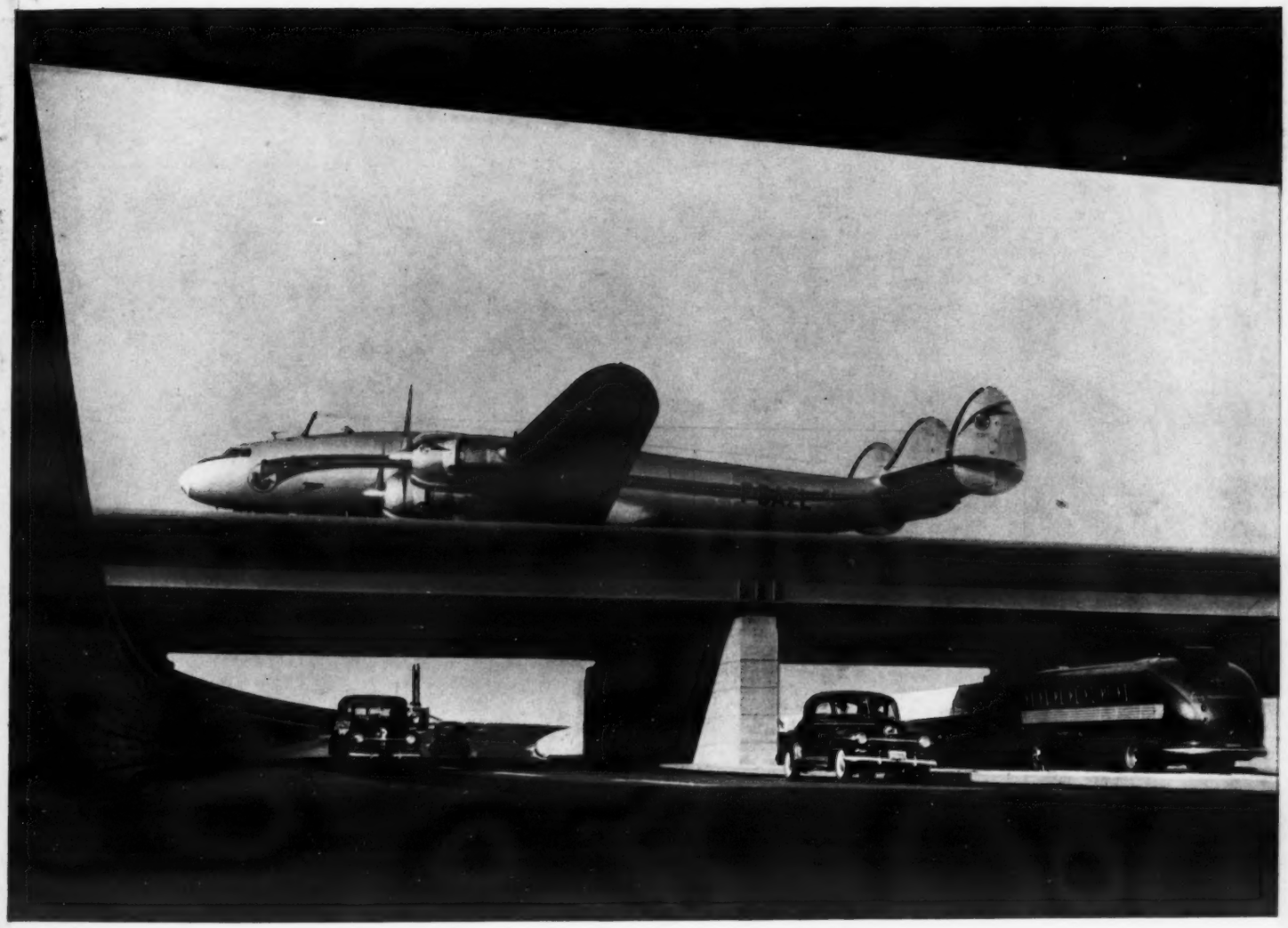
INTER AVIA

Review of World Aviation



In this Issue:

Pan American merges with American Overseas

Treaties in the Era of Aerial Warfare

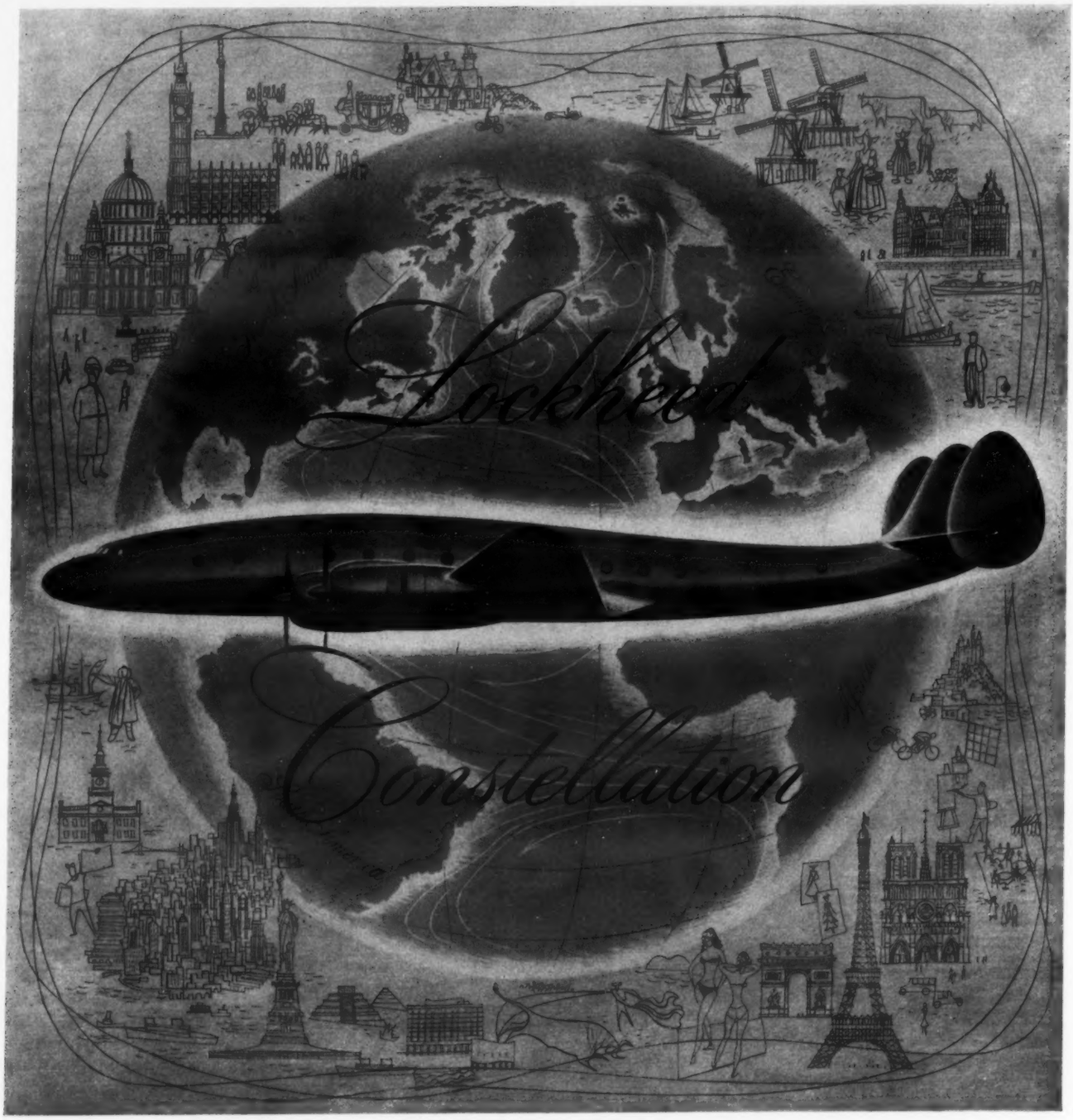
Saab "Scandia" — Studying the Flying Qualities

W. Horten : Better Performance with Tailless Sailplanes

Microplanes — "Gorgon IV"

Economic Aspects

VOLUME IV No 2 FEBRUARY, 1949



Queen of the Atlantic

The superior comfort and speed of the Lockheed Constellation has made it the ruler of the Atlantic by popular acclaim.*
And too, the Constellation's greater range and operating efficiency, tried and proven through nearly four thousand million passenger miles, makes it the leader on twelve global airlines.

* The Lockheed Constellation carries twice as many passengers across the Atlantic every month as all other types of transport combined

Lockheed Aircraft Corporation

BURBANK, CALIFORNIA

INTERAVIA

Review of World Aviation

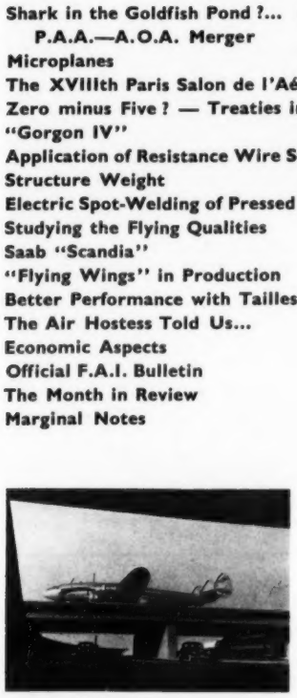
OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F.A.I.)

Volume IV | February, 1949 | No. 2

Board of Directors : Marcel Devaud, Edgard Primault, Eugen Groh, E. E. Heiman, O. H. C. Messner, E. V. D. Wight, Jr.
Editors : E. E. Heiman. H. T. Biland, E. de Tavel, E. Herzfeld.
Assistant Editors : Patrick A. Sauter, E. Cherbuliez, J. Jenny, A. de Rham, A. Arbex, E. Baur.
Art Editor : H. W. Mahrer.
Advertising : S. Bollag.
Publishers and Distributors : Interavia S. A. **Proprietors :** Volamecum S. A.

Contents

Shark in the Goldfish Pond ?... No, King of the Seas ! P.A.A.—A.O.A. Merger		**71**
Microplanes		**77**
The XVIIIth Paris Salon de l'Aéronautique		**79**
Zero minus Five ? — Treaties in the Era of Aerial Warfare		**80**
"Gorgon IV"		**84**
Application of Resistance Wire Strain Gauges	W. RAMBERG	**87**
Structure Weight	S. CURREY	**89**
Electric Spot-Welding of Pressed Sheet Parts	G. BRUNER	**93**
Studying the Flying Qualities	H. BRÜCKNER	**97**
Saab "Scandia"		**99**
"Flying Wings" in Production		**103**
Better Performance with Tailless Sailplanes		**104**
The Air Hostess Told Us...		**108**
Economic Aspects	FREDERICK PETERS	**109**
Official F.A.I. Bulletin		**111**
The Month in Review		**112**
Marginal Notes		**114**



Front cover :

Van Wyck Approach Road, Idlewild ; apron underpass

Appears Monthly in Four Editions : English, French, Spanish and German.
Publishing and Editorial Offices, Subscription Department : Interavia S. A., 6, Corraterie, Geneva

Advertising Department : 6, Corraterie, Geneva. Telephone : 54234 (five lines). Cables and Telegrams : Interavia-Geneva.

Prices : Switzerland : annual subscription, Sw. frs. 25.00; single copy, Sw. frs. 2.50. Annual subscriptions in other countries : U. S. A., $8.00; Great Britain, £2 0s 0d; France, Fr. frs. 1,000.00 for 6 months and Fr.frs. 1,800.00 for12 months; Belgium, Belg. frs. 350.00; Denmark, Kr. 40; Argentina, $ m/n 45.00; all other countries, Sw. frs. 30.00.

Agents and Distributing Offices :

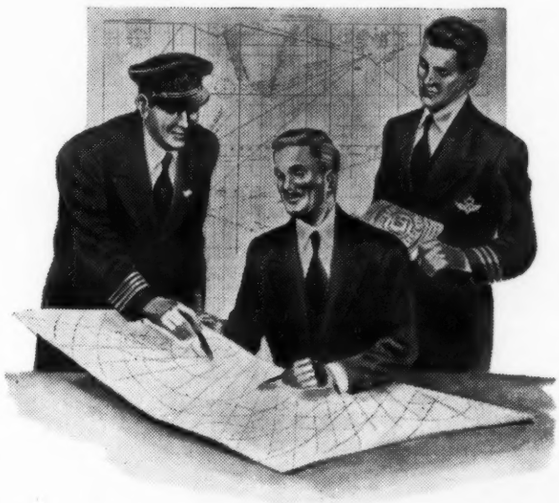
INTERAVIA BELGIUM :	11 Rue de Crayer, Brussels, or Office de Publicité, 36, Rue Neuve, Brussels.
INTERAVIA DENMARK :	Leopardvej 37, Copenhagen/Valby. Dansk Centralagentur, Stormgade 20, Copenhagen.
INTERAVIA FRANCE :	144, Champs-Elysées, Paris VIII°.
INTERAVIA GREAT BRITAIN :	Interavia (United Kingdom) Ltd., Standbrook House, 2-5, Old Bond Street, London, W.1.
INTERAVIA HOLLAND :	Diepenheim (O.) Warmelo S. 13. M. van Gelderen & Zn., Postbox 826, Amsterdam-C.
INTERAVIA HUNGARY :	Ibusz, Akadémia-utca, 10, Budapest, V.
INTERAVIA ITALY :	39 Viale di Villa Massimo, Rome.
INTERAVIA SWEDEN :	Postbox 29, Linköping.
INTERAVIA U. S. A. :	155 East 44th Street, Room 2903, New York City, N.Y. Subscriptions also from the International News Co., 131 Varick Street, New York, N.Y.
INTERAVIA BRAZIL :	38 Rue Teofilo Otoni, Rio de Janeiro.
INTERAVIA EGYPT :	59, Avenue Malika Nazli, Cairo.
INTERAVIA SOUTH AFRICA :	P. O. Box 6073, Johannesburg.

Copyright 1949 by Interavia S. A., Geneva, Switzerland

Printed in Switzerland

Imprimeries Populaires, Geneva — Héliographia S. A., Lausanne
Imprimerie "Tribune de Genève," Geneva

Every K·L·M flight is planned beforehand



A perfect co-operation between the weather experts, the technical staff and the experienced K.L.M. crews, gives every K.L.M. flight a maximum of safety and efficiency.

Flying to all parts of the world every K.L.M. plane gives its passengers a maximum of comfort and speed.

Plan your pleasure and business trips by K.L.M.

K·L·M

ROYAL DUTCH AIRLINES

Some Short jottings for airline operators, charter companies, and V. I. P. s

Sea Island Service

The Sealand is chosen

Trinidad, on the border of the Caribbean, is the key to new territory served by the amphibian Sealand. B.W.I.A., the subsidiary of B.S.A.A.C., have recently ordered three of these versatile aircraft for general duties among the West Indian Islands.

They could not have made a better choice.

The Sealand, which is equally happy on land or sea, is the perfect aircraft for an area where landing strips are few and far between.

B.W.I.A.'s new 'Sea Island Service,' which will operate daily between Trinidad and the Windward and Leeward Isles, will call upon the Sealand for all kinds of work.

For Itself

All kinds of work? Yes, because Shorts have specially designed the Sealand as the most easily convertible amphibian on the market.

Mooring the Sealand is a simple operation carried out entirely by the pilot.

It can be used for the rapid transport of passengers or freight, as a luxurious flying office, or as an air ambulance. In any of its roles it will give the greatest service at the lowest cost.

The Sealand's range is elastic. With 54 gallons and a payload of 1,400 lbs. — which is equivalent to seven passengers and baggage — the Sealand can cover nearly 350 miles at a speed of 150 m.p.h. But 120 gallons of fuel, and 994 lbs. of freight, give it a range of 765 miles. The Sealand's reversible pitch propellers endow it with high manœuvrability in the most congested waterways. It has a take-off run of 550 yards and climbs at 880 ft. per minute.

These are only a few reasons for its immense value to charter companies and feeder lines.

B.W.I.A.'s Sealands will operate twice-weekly over this main route, with 'flag-stops' at the smaller islands. Dominica and St. Vincent are sea-dromes.

For Others

On the 'Sea Island Service' the Sealand needs no great range. It will be used for short hops from island to island, providing a much-needed means of inter-island transport.

But consider its practical value to plantation owners and estate-managers who need a general 'hold-all' to take them and their stores to outlying districts. In this case, the Sealand, with a petrol consumption of 6 ground miles per gallon, is the answer to many of the executive's problems. If you have scattered estates, not easily accessible by overland routes, Shorts are confident that the Sealand can be adapted to your needs. Why not ask Shorts for details?

For the Record

North, South, East, and West, airlines are availing themselves of the unique service provided by Short flying boats. Over short distances or long the famous S's — the Sandringham, the Solent, and now the Sealand — are proving the value of the Short story in air travel.

FLYING BOAT PERSONALITIES

Captain

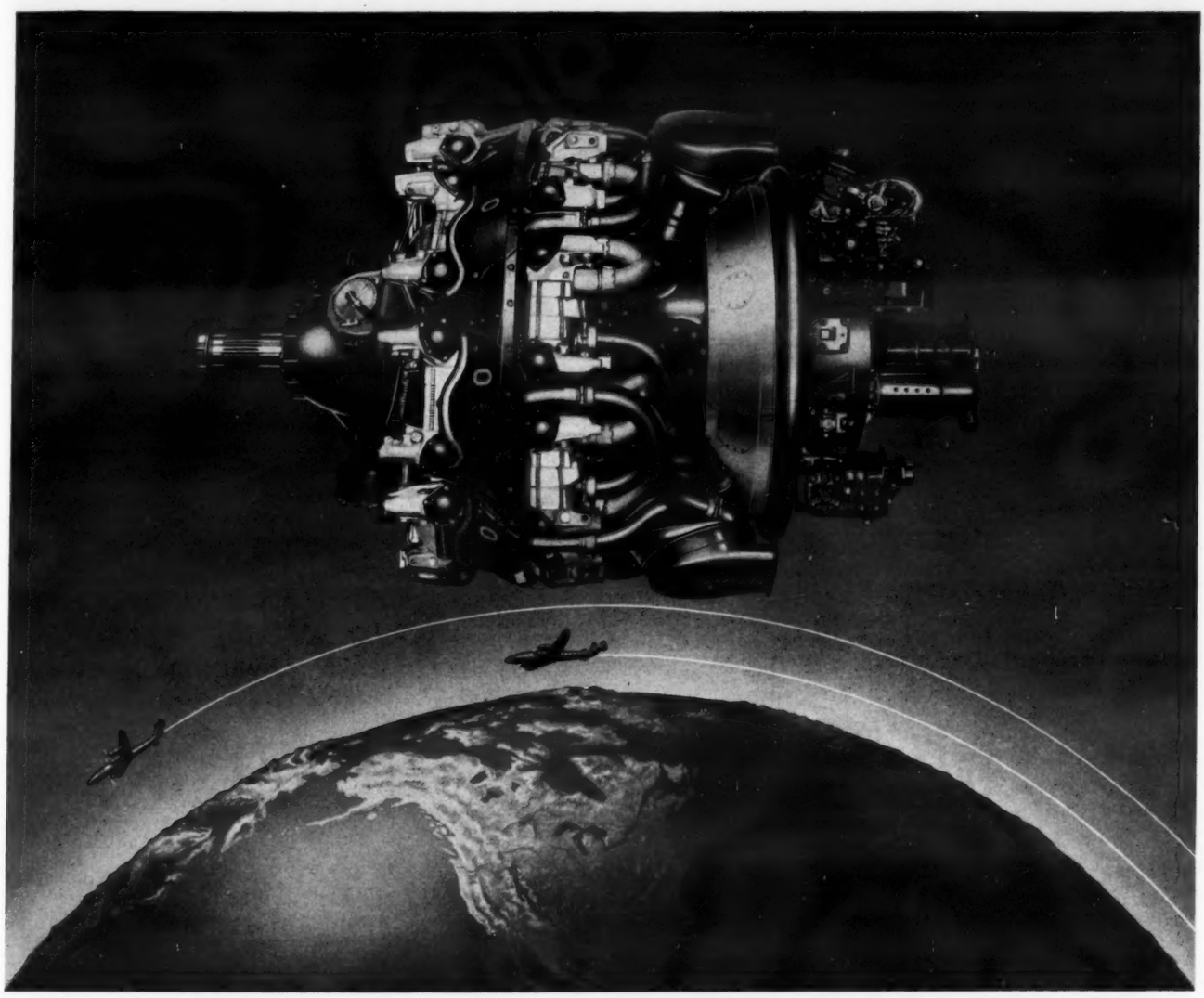
J. S. SHEPHERD

T.E.A.L.

Captain J. S. Shepherd has been on the staff of Tasman Empire Airways Limited since 1945, but his flying career dates from 1939. He trained in Canada and served with No. 228 Squadron in Scotland, and in West Africa with No. 490 Squadron. He returned to New Zealand as a member of the delivery flight which flew the first Sunderland aircraft for the R.N.Z.A.F. from the United Kingdom to Auckland. He was awarded the Air Force Cross for outstanding service during the War. He is a keen sportsman, having represented Otago in provincial Rugby football matches. He is also a sprinter of some note.

Shorts THE FIRST MANUFACTURERS OF AIRCRAFT IN THE WORLD

Short Brothers & Harland Ltd., Queens Island, Belfast · London Office : *17 Grosvenor Street, W.1*



ANNOUNCING THE NEW *Turbo-Cyclone 18* COMPOUND ENGINE

Longer range, increased payload, greater economy and higher power output are provided by this latest Wright Aeronautical Corporation development.

▶ The Turbo-Cyclone 18 combines the dependable performance of the reciprocating engine with the simplicity and compactness of the gas turbine. It utilizes a sizable portion of the energy in the exhaust gases of a reciprocating engine to drive three turbines that are geared back to the engine crankshaft.

▶ To the operator the Turbo-Cyclone 18 offers a choice of (1) a reduction in specific fuel consumption of as much as 20%, (2) a 20% increase in range on the same amount of fuel, (3) a substantial increase in payload because of the reduced fuel consumption, or (4) a 20% increase in power for the same amount of fuel. Additional bonuses include...

▶ *lower specific weight*—less than one pound per horsepower developed... *ease of installation in existing aircraft*—fits within cowl lines of existing nacelle... *ease of maintenance*—no additional cylinders—readily removable turbine units... *ease of operation*—no additional controls—no specialized training of flight crews.

▶ The production of the Turbo-Cyclone 18 fulfills today's requirements for optimum economy and performance in long range aircraft.

▶ Another example of Wright engineering leadership in developing new power-plants for the aviation industry.

POWER FOR AIR PROGRESS

WRIGHT

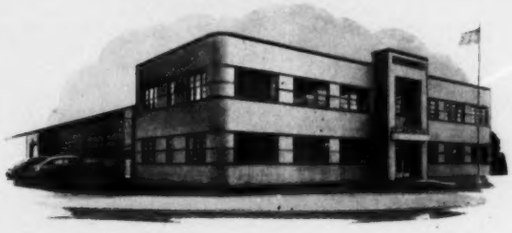
Aeronautical Corporation · Wood-Ridge, New Jersey

EXPORT DIVISION, 30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK, U. S. A.

A DIVISION OF CURTISS WRIGHT FIRST IN FLIGHT

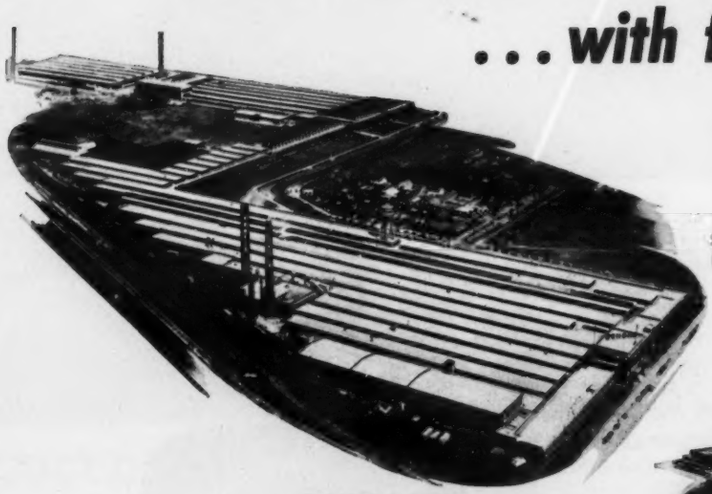
Bendix
INTERNATIONAL
Products

SKINNER PURIFIERS DIVISION
Aircraft Filters



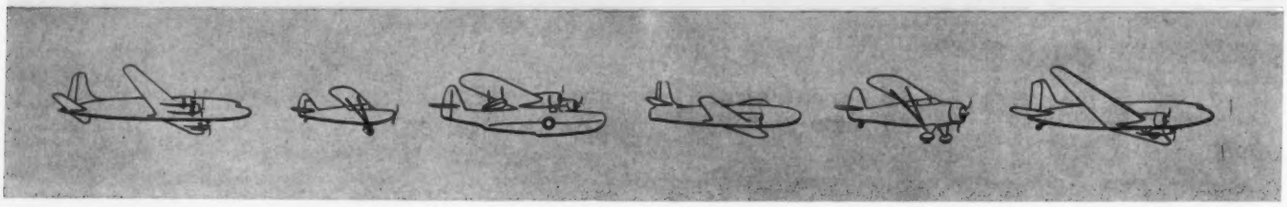
The Great Bendix Family

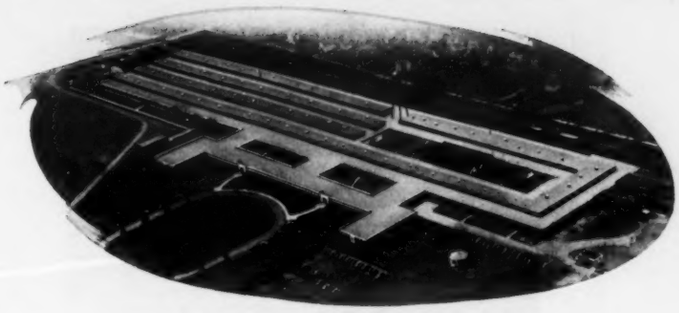
... with fine products for every aviation need



BENDIX PRODUCTS DIVISION
Stromberg* Injection Carburetors
Direct Fuel Systems, Landing Gear :
Brakes, Wheels and Struts

ECLIPSE-PIONEER DIVISION
Flight Control Instruments
Aviation Engine Components
Automatic Pilots





SCINTILLA MAGNETO DIVISION
(USA)
Aircraft Ignition Systems

BENDIX RADIO DIVISION
Air Communication Radio and Ground Transmitters

RED BANK DIVISION
Dynamotors

Serving YOU...

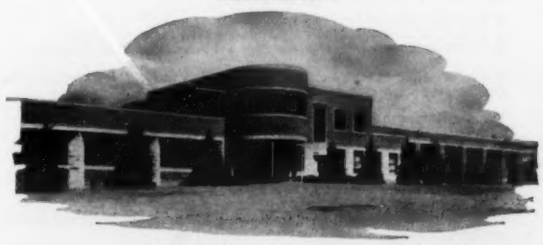
People everywhere are familiar with the name Bendix as a symbol of the finest in aviation products. To maintain this position, Bendix has built a vast organization extending all over the world. It begins at these huge factories, each producing different equipment but all achieving the same high standards of excellence. It also includes complete export offices to handle all of the difficult shipping problems. And finally, there are the factory-trained field representatives in every country standing ready to give assistance in any way, from original specifications to final installation. In short, Bendix is a world-wide family — a great family serving you.

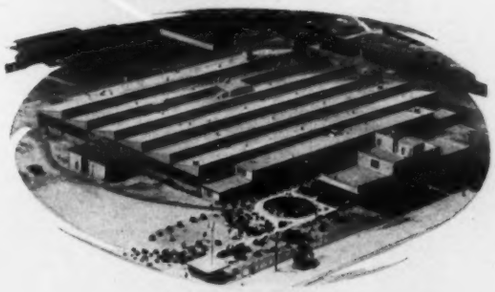
*Reg. U.S. Pat. Off.

BENDIX INTERNATIONAL DIVISION of
72 Fifth Avenue - New York 11, N. Y.

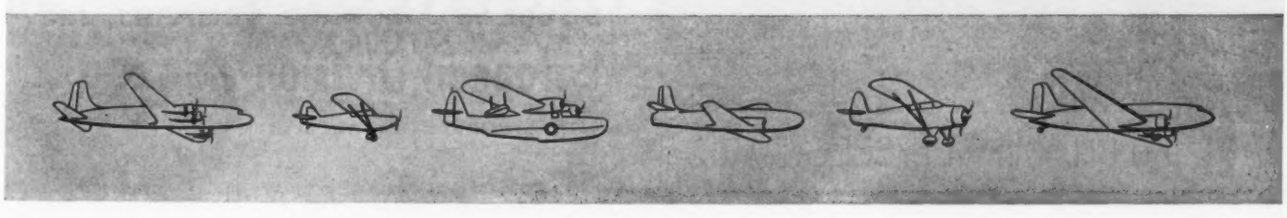
Bendix
AVIATION CORPORATION

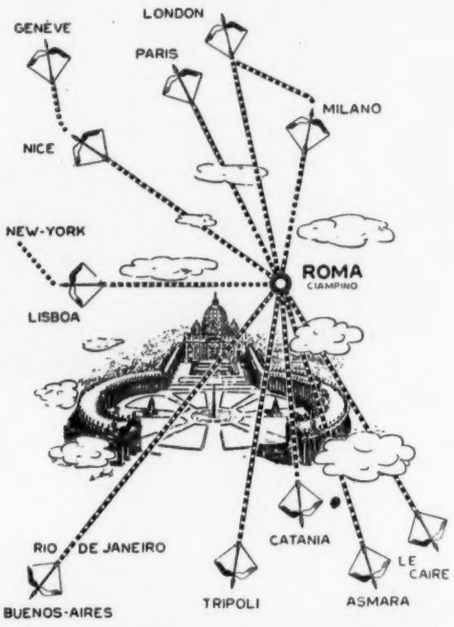
BENDIX FRIEZ DIVISION
Radiosonde and Meteorological Instruments





PACIFIC DIVISION
Hydraulic and Electrical Aircraft Components





SERVICES ALITALIA

ROME, VIA BISSOLATI 20 — TELEGRAMS : ALITALIA-ROMA

International and Italian air routes
Bookings in Switzerland by Swissair and all travel agencies

Sphinxworks Muller & Co. Ltd.

Precision machine cut screws & turned parts
Small drills and taps

Soleure (SWITZERLAND)

SOCIÉTÉ D'ÉTUDES ET D'EXPLOITATION DES HÉLICES
RATIER
70 CHAMPS ÉLYSÉES . ÉLY. 93-43
freinage et drapeau rapide
70 CHAMPS ÉLYSÉES. PARIS

You owe it to your passengers...

When they choose your airline, passengers expect regularity. Your Douglas airplanes should enable you to live up to your passengers' expectations—provided proper maintenance is carried out and only entirely reliable spares are used to replace worn parts.
Warranted Douglas Spares, which you can obtain from the Douglas Aircraft Company give you the greatest guarantee of reliability, and therefore of contented passengers.

Stocks at our Brussels depot include :

- *Complete sets of spares for current maintenance needs*
- *Parts and assemblies liable to accidental damage but not to wear*
- *Many accessories in current use, but not manufactured by Douglas.*

If your country is eligible, apply to your Government for assistance in purchasing your spare parts under the "Marshall Plan."

Douglas European Division brings you Douglas Service in Europe :

- *Factory-new, Warranted Douglas Parts*
- *Standard Douglas prices*
- *Deliveries on promised date*
- *Douglas-trained technicians to aid you*

Cable or telephone us if in urgent need of spares or technical advice—and write for full details of the Service we offer you.

DOUGLAS AIRCRAFT COMPANY, INC.

European Division DOUGLAS

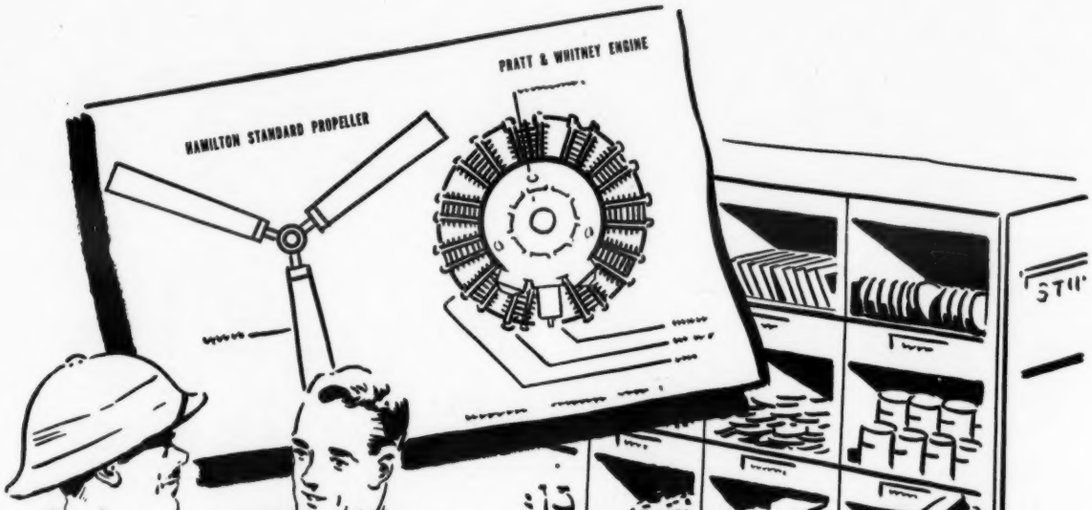
1470, Chaussée de Haecht, Aérodrome de Haren
Brussels **Belgium**

CABLES : DOUGLASAIR-BRUSSELS **TELEPHONE . 16.06.45**

The Canadair Four ... has been chosen by Canadian Pacific Air Lines to develop its passenger services in the vast North and South Pacific. British powered and Canadian built, this Commonwealth Aircraft has the flexibility essential to the diverse airline operations of the great Canadian Pacific System.

Canadair Limited

MONTREAL, CANADA



Dependable Service — Everywhere

United's field service men, strategically located around the globe, are available on short notice to offer expert advice and assistance on operating problems.

Always informed on current production and latest installations, these service experts help operators everywhere in the swift procurement of correct spare parts and tools. Under emergency conditions, these spare parts are only a few days by air from anywhere.

These service men have won a reputation for quick and helpful service which is as dependable as the engines, propellers and aircraft built by United Aircraft Corporation.

These services help the operator to achieve the maximum in safe, trouble-free and profitable performance.

UNITED AIRCRAFT
Export Corporation
EAST HARTFORD, CONNECTICUT, U. S. A.

European Office
4, rue Montagne du Parc
Brussels, Belgium

PRATT & WHITNEY	HAMILTON STANDARD	CHANCE VOUGHT	SIKORSKY
ENGINES	PROPELLERS	AIRPLANES	HELICOPTERS

Shark in the Goldfish Pond?... No, King of the Seas!

22ND DECEMBER, 1948 *Pan American Airways takes over American Overseas Airlines* *

The man has made his mark. His story will go down in the annals of aviation history. There is no doubt that Juan Terry Trippe, President of Pan American World Airways, is today the leading man in world aviation.

It strikes me as if it were only yesterday...

I was one of a small group of guests of American Airlines and American Overseas Airlines one evening in May, 1947. We sat together at the Twenty-One Club, the fashionable New York restaurant which is a meeting place of celebrities from all fields, including aviation. C. R. Smith, Chairman of A.A. and President of A.O.A., who was quite unknown in 1929 when he left his native Texas to lay the foundation stone of American Airlines, later to develop it into the most important U.S. domestic carrier and in 1944—by taking over the share majority of American Overseas Airlines—to build it into a global organisation, was spinning yarns about his early days.

Everybody was in a good humour, although a few small clouds were already discernible on civil aviation's horizon. The critical trends which were to beset the airlines during the second half of 1947 and also during 1948, were not yet quite noticeable.

We spoke of the North Atlantic, of the sharp competition between the three U.S. rivals, Pan American Airways, American Overseas Airlines, and Trans World Airline. Everyone realised that the situation was by no means simple. But C. R. Smith seemed determined to fight.

Maybe I was imprudent, or altogether too optimistic. Without malice, I said to Smith: "One day you will come to some sort of an arrangement with Mr. Trippe, and some form of co-operation between Pan American Airways and American Airlines will be conceived." In that moment I had laid my cards before Smith, Chairman of A.A. His expression hardened. He brushed off my suggestion contemptuously. As far as he was concerned, I was a daydreamer, a complete fool.

Guests of A.A. and A.O.A. at New York's Twenty-One Club (left to right): Dr. R. Speich, President of Swissair; General Cyrus R. Smith, Chairman of A.A. and President of A.O.A.; Eugen Groh, Director of Swissair; General Harold R. Harris (on the right, back to the camera), Vice-President and General Manager of A.O.A.

It strikes me as if it were only yesterday...

What have you to say about it today, General Smith?

What is your present opinion on the announcement you released on December 12th, 1948, jointly with your new partner, Juan T. Trippe? I do not wish you to deduce any irony, pretentiousness, or malice from my question. I offer my heartiest congratulations to you and Mr. Trippe on the new plan for co-operation. Nevertheless, it remains to be seen whether the congratulations from all airline circles will be numerous. That depends on you and Mr. Trippe. But we shall speak of that later.

*

At the beginning of December, 1948, our U.S. correspondent reported that it looked as though American civil aviation was on the up-grade. The biggest difficulties seemed to have been overcome, the era of red-ink reports over, and the year 1949 ought to bring forth better results for the majority of companies, at least for the well-managed ones, than the two preceding years.

It so happens that our correspondent based his prognostics on the fact that the New York Stock Exchange had, at the end of November, 1948, discovered its "love for airline shares," and that notably American Airlines shares were remarkable for their firmness.

Our editors took note of this and we published these findings in our daily newsletter, the "Air Letter," though without commenting further on the matter. Our New York ears and eyes might after all be right, though the prophecy struck us as being almost too good to be true. We were unable to formulate an opinion. Incidentally, we were not alone in this respect, for the majority of people were unaware of what was happening—until on December 8th, 1948, the Dow-Jones financial news service in New York released the first reports that Pan American Airways and American Airlines were pursuing negotiations with a view to bringing about a fusion of the two companies, and that these negotiations were almost completed.

Like everyone else, we were astonished, and at first reluctant to believe it.

Of course, we had known for about a year that there was a possibility of Pan American Airways taking over its financially-weakened rival, Trans World Airline, or at least buying out T.W.A.'s overseas routes. At the beginning, we were inclined to assume that T.W.A.'s major sharedholder, the young and stubborn industrialist Howard Hughes, had finally decided he liked the oil and film industries better than the airline business; that his T.W.A. job was gradually becoming too big for him, and therefore a P.A.A.-T.W.A. merger was within the bounds of possibility. Finally, these assumptions were supported by the fact that P.A.A. had long been endeavouring to obtain permission from the C.A.B. to fly U.S. domestic routes. But that is another matter we shall discuss later. There is no doubt that negotiations did take place between P.A.A. and T.W.A., and no less doubt that they have come to a temporary impasse due to Howard Hughes' characteristic peculiarities.

The report from New York of December 8th was followed on December 12th, 1948, by a very unambiguous announcement: American Airlines and Pan American Airways have reached an agreement.

* INTERAVIA, Review of World Aviation, Vol. III, No. 9, pp. 495-498.

This is the news as it was published jointly on December 12th by A.O.A. and P.A.A. :

American Overseas Airlines and Pan American Airways announce that an agreement has been concluded between the two companies looking to a consolidation of the A.O.A. routes with the trans-Atlantic services of Pan American. The agreement is subject to the approval of the Civil Aeronautics Board and the stockholders of the two companies...

The agreement contemplates the transfer of the assets of American Overseas to Pan American, in exchange for stock of Pan American. It is planned that the stock of Pan American received by American Overseas will be distributed to its stockholders and Overseas will thereafter be dissolved. As a major stockholder in American Overseas, American Airlines, Inc., will acquire a stock interest in Pan American. American has no plan to take part in the management of Pan American and the stock received by it will be placed in a voting trust until ultimately sold to the public or distributed to its stockholders.

The amount of stock involved in the transaction cannot be definitely estimated at this time. That figure will be ascertained by independent auditors who will determine the fair value of the assets and liabilities of both companies as of December 31st, 1948.

The contract provides that Pan American will, at the time of the transfer, take over the employees of American Overseas, [approx. 1,300—Ed.] and thereafter will endeavour to provide continuing suitable employment for them, in the light of their experience and qualifications.

It is believed that the integration proposed is in the public interest. Much weight was given to recent suggestions of Chairman Joseph O'Connell, Civil Aeronautics Board, that the air transport industry "give serious consideration to desirable mergers and consolidations."

The "reasons for this decision on the part of American Overseas," as stated by C. R. Smith, President of that company, "were predicated on the slow revival of normal trade and commerce between the United States and Europe ; the fact that the foreseeable volume of business does not justify the continuation of three competing United States carriers on the North Atlantic route ; the increased subsidy which will be required to sustain three carriers ; and the difficulty of securing the additional capital which will be required for the future."

Cyrus R. Smith, Chairman of A.A. and President of A.O.A.

Juan Terry Trippe, President of Pan American.

Juan T. Trippe, President of Pan American Airways, referred to the fact that foreign-flag airlines have increased the proportion of traffic carried by them more than 50 per cent. during the past year. "As a result of the merger, important operating economies would be effected. The financial position of the carriers would be strengthened, and the opportunity of preserving a fair share of future North Atlantic air traffic under the American flag would be greatly improved."

*

It all reads likes a passage from the Bible, pious and good. The man in the street, learning of the agreement between Presidents Smith and Trippe from his morning newspaper, must have rightly thought : Two clever, sensible men, with their hearts in the right place ; two benefactors of humanity, or at least of civil aviation.

The background to this transaction is not mere kindness ; it is much more concerned with long-term planning and a few dozen million dollars. The announcement of December 12th was concerned with the biggest merger in the history of civil aviation, and can in many ways change the entire picture of world civil air transport. In view of this, a few questions arise, which must be clarified before the significance of this contract can be appraised correctly :

a) Who are the two contracting partners ?
b) What is the ultimate goal of this contract ?
c) What effects will this contract have on U.S. civil aviation ?
d) What could its effects be on international civil aviation ?

In answering these questions we will perhaps reach surprising conclusions. The subject certainly leaves no room for boredom. Dioscuri Trippe and Smith are playing for very high stakes ; stakes which will probably be matched by the gains.

*

The early history of Pan American World Airways was broadly outlined in the September, 1948, issue of this magazine.

We will briefly repeat how in 1926 a U.S. Air Corps officer—*keep in mind that his name was Captain H. R. Harris*—was sent to Peru to handle certain business deals connected with cotton, which apparently did not turn out to his advantage. However, young Harris was not dull, and he all the same learned something during his South American trip. He was one of the first North Americans to recognise the poverty of transportation in Latin America, and consequently the possibilities offered to civil aviation in that part of the world. He contacted the President of W. R. Grace & Co., the big shipping concern, and won him over. The result was the foundation of Pan American-Grace Airways, also known as Panagra, which today flies between South and North America and owes its origin to young Harris. This was followed by the foundation of Pan American Airways, Inc., for operating overseas routes from the U.S.A., and finally by the formation of a parent company in the shape of Pan American Airways Corporation. Under the latter's roof there are today at least sixteen airline companies, based in both the Americas, in Asia and other parts of the world. Moreover, a further subsidiary founded in the winter of 1947, Intercontinental Hotels Corporation, looks as though it is due to become of the world's leading hotel concerns.

But to return to young Captain H. R. Harris, it should be noted that he, too, continued to progress in many ways. He even became a General. However, in the year 1931, there appeared alongside him another star in the P.A.A. constellation, a man named Juan Terry Trippe, who, apart from having a lot of commonsense, also had excellent connections with the American financial world. It was not long before Trippe became President and the real leader of Pan American Airways System.

With Trippe at the reins, P.A.A. and its subsidiaries in South America and Asia made excellent headway. Up to the outbreak of war, P.A.A. made it its main job to operate routes from the American frontiers and between points outside the U.S.A. In this respect the company had a silently-recognised American monopoly. For at that time the U.S. domestic carriers were little if at all interested in the international business.

Glimpses of P.A.A.'s hotel organisation : Dining room at Grande Hotel in Belem, Brazil. Cocktail lounge at P.A.A. Guest House, Port of Spain, Trinidad.

Matters took another turn when World War II broke out, and especially when it came to an end.

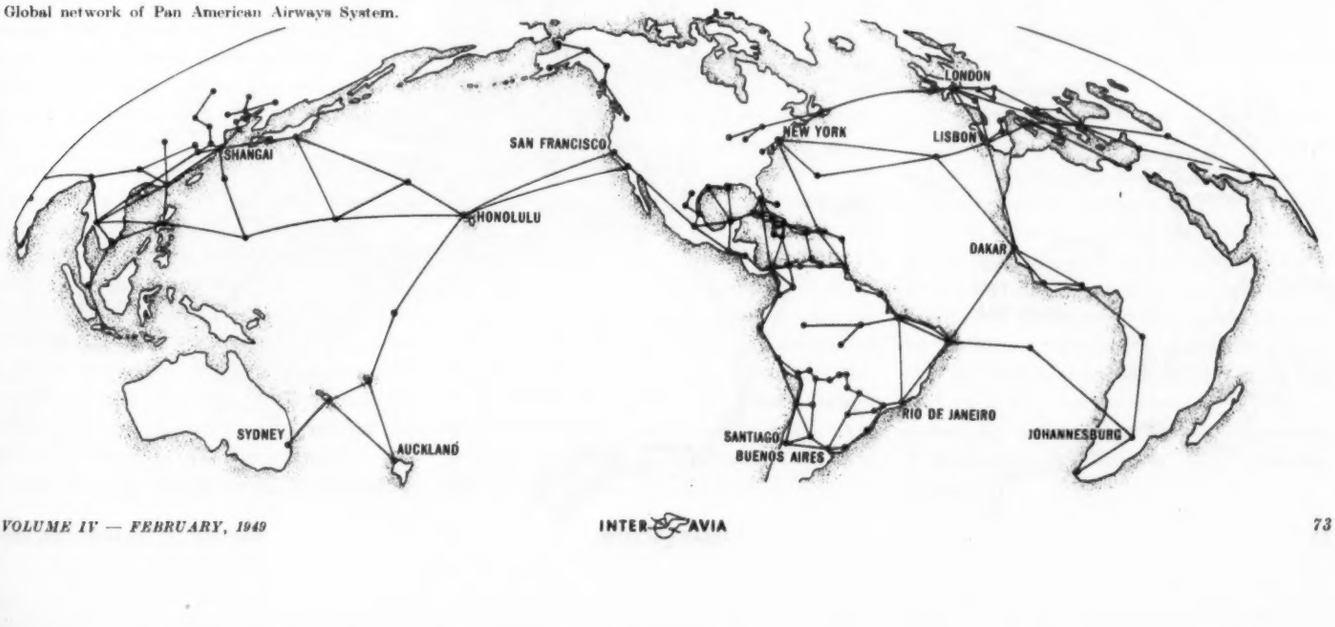
First of all, the second World War brought with it manna from heaven for P.A.A. and its subsidiaries in South America ; for the concern was now able to get the better of its strongest competitor. If it is accurate what the Bible says—that the Lord giveth to the just while they sleep—then Mr. Trippe must certainly be a very pious person. To put it briefly, in the second, enormous part of the development of his company, Mr. Trippe acquired a mighty helping hand in the person of Adolf Hitler. It so happens that on the South American continent, in China, and on the South and North Atlantics, the former German Lufthansa was the strongest rival of P.A.A. and even stronger than the American company at certain times. In China, for instance, the German carrier had a well-managed and prosperous subsidiary in the Eurasia concern ; in Brazil it controlled the former mighty Condor-Syndikat ; in Bolivia there was the Lloyd Aero Boliviano, and in Colombia the Scadta airline. All these airline companies had been built up with plenty of German capital. To put it in a nutshell : Hitler got his war and, with characteristic thoroughness, was able to destroy the German Lufthansa organisation ; and P.A.A. acquired these companies... with their organisation, ground facilities and experience thrown in. Whereas all this meant smooth sailing for P.A.A., there were other fields in which the going was rougher.

At the end of 1941 the U.S.A. entered the war, and as this war had to be fought on all continents, the American General Staff understandably took a keen interest in having an efficient supply organisation, including a powerful air transportation system. In consequence, a place was given in this organisation even to U.S. airline companies which had formerly operated only within the frontiers of the U.S., and understood little of overseas traffic, having perhaps never even given it a thought.

Among the most prominent of these were American Airlines, on the North Atlantic ; its competitor on transcontinental routes, Transcontinental & Western Air, Inc., now better known as Trans World Airline ; a competitor of both of these carriers, United Air Lines ; and a number of others. These carriers started to fly over the Atlantic and the Pacific, to Europe, India and Australia. Apart from this, another sharp rival for P.A.A. cropped up shortly before the war, American Export Airlines, at that time a relatively unimportant carrier which has been specially created for overseas operations. Originally formed by American Export Lines, a shipping concern, it developed notably during and after the war.

Pan American had still another stroke of bad luck : in 1942 it was not Juan T. Trippe who was nominated Chief of Staff of the U.S. Army Transport Command—to whom the entire U.S. military transportation system was subordinated—but the top executive of American Airlines, C. R. Smith, who was promoted Brigadier-General and later Major-General. But already in 1942, Mr. Smith and a number of his airline friends, knowing perfectly well that one gains appetite while eating, had no intention whatever of leaving to Pan American Airways its pre-war monopoly on overseas air traffic.

Global network of Pan American Airways System.



What was P.A.A.'s reaction ? Given no alternative but to pick up the gauntlet, it pledged itself to the banner of nationalism. It coined the term "chosen instrument" for a single U.S.-flag airline operating overseas routes, which alone would display the Stars and Stripes over every foreign part of the world. It goes without saying that P.A.A. had chosen itself as the chosen instrument. But its calculations were upset. A number of U.S. Senators, Representatives, and the head men of the Civil Aeronautics Board were reluctant to allow Pan American to become too mighty. They expressed the opinion—perhaps as they themselves will admit today, somewhat hastily—that a certain amount of competition could only be of benefit to P.A.A.

And when the war came to a close, the Americans started dividing up the world's airspace anew. Besides Pan American Airways, there were now two other carriers flying the North Atlantic : Trans World Airline and American Airlines. To be quite accurate, the latter company was operating through a subsidiary, American Export Airlines, whose share majority they acquired in 1944 and later re-named American Overseas Airlines.

By way of precaution, the CAB had divided up the North Atlantic air routes into three networks. The northern network, over London, Holland, Scandinavia, up to Moscow, and including the German territory up to Frankfurt, was given to American Airlines, or rather its subsidiary, American Overseas Airlines. The middle network, covering Belgium, Germany (also Frankfurt), Czechoslovakia, Austria, the Balkan countries and further on via Egypt to the Far East, was handed to P.A.A. The southern network, embracing Paris, Switzerland, Egypt and India, was to be flown by T.W.A. True, some of these routes overlapped, and matters did not always work out because of the Russian obstruction to foreign operators and the barricading of the airspace over the Balkan countries. By and large, however, these three networks were planned to cover the globe. And the carriers flying them were consequently in competition with one another.

Of these three U.S. carriers, one can really say that, as regards publicity for acquiring customers, they did not leave a single stone unturned. For instance, one could find in one and the same publication, an advertisement reading "Fly A.O.A. to U.S.A." and a few pages further on another advertisement worded : "Pan American World Airways, only airline flying to all six continents... New low fares to New York." Basically, they were all flying the same routes, with more or less the same aircraft types, namely Lockheed "Constellations" or Douglas DC-4s ; they were serving the same cocktails and steaks on board. Apart from the air hostesses' uniforms, very little difference existed.

As you see, therefore, the pre-war goldfish pond of P.A.A. had become invaded by a number of sharks in the shape of A.O.A. and T.W.A.

*

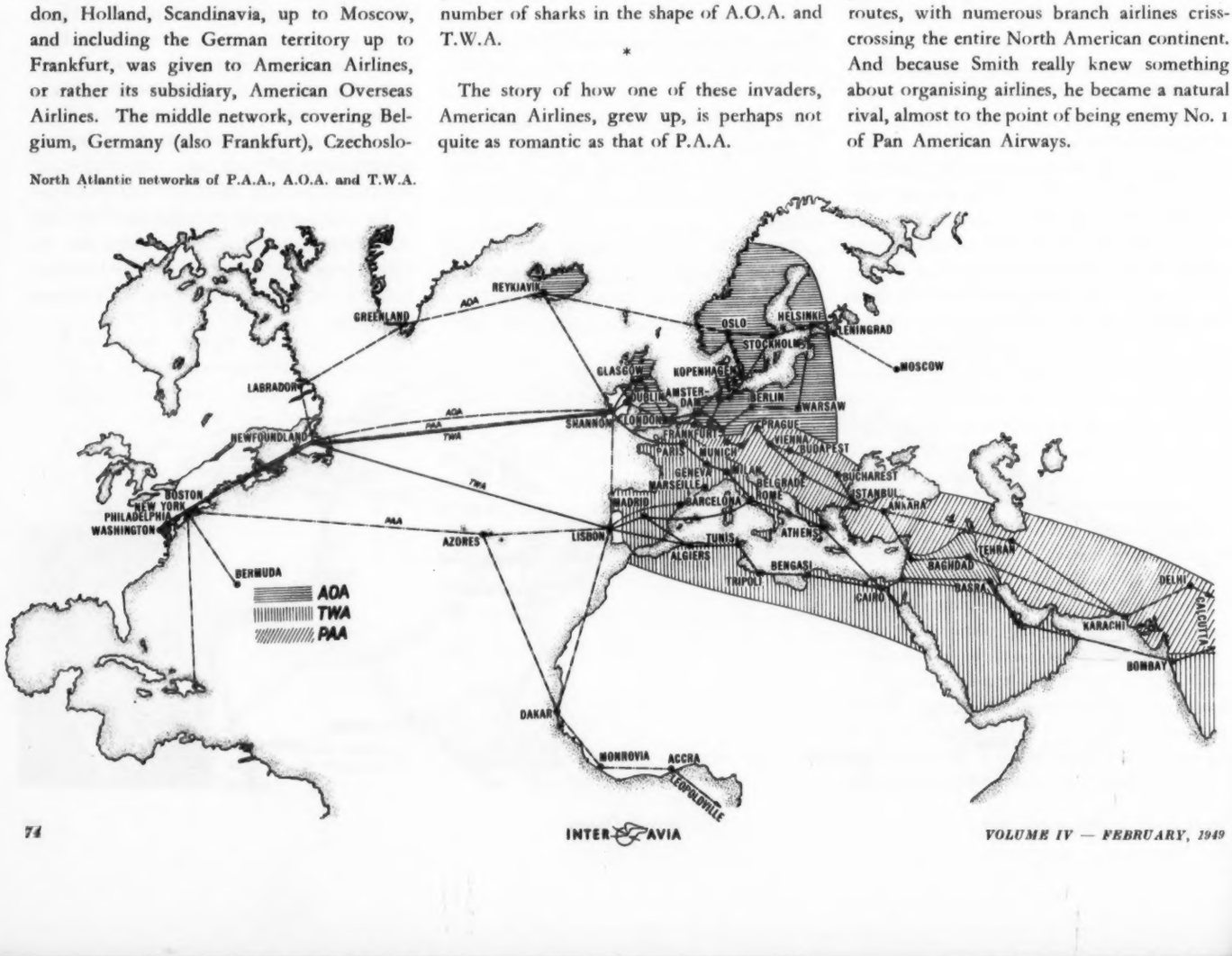
The story of how one of these invaders, American Airlines, grew up, is perhaps not quite as romantic as that of P.A.A.

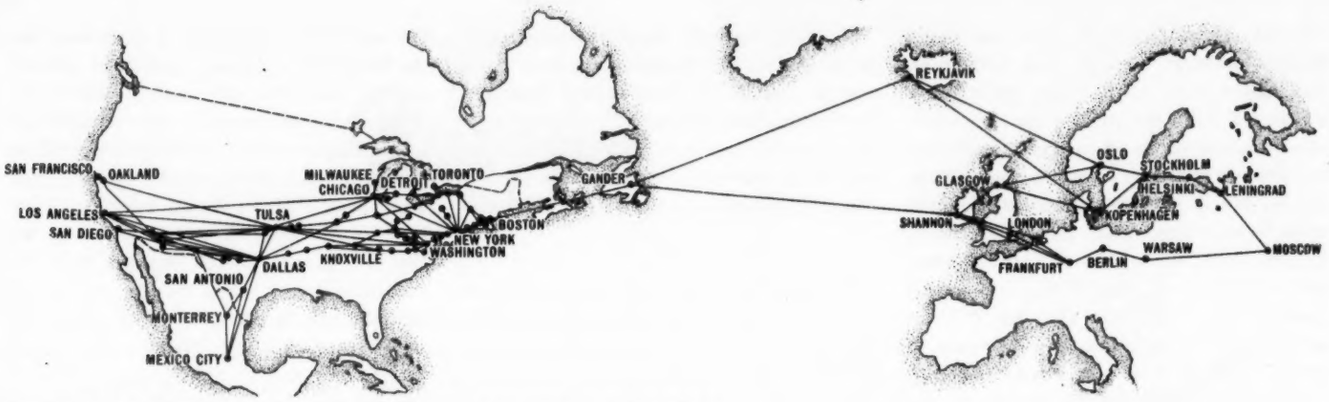
In the year 1928, Texan-born Cyrus R. Smith discovered his vocation for airline management. First of all he founded a firm called American Airways, which flew a number of routes in his home state and in the south-west of the U.S.A. And because he was more diligent than his competitors, he gradually took over a number of the smaller local carriers. In 1934 his airline group was registered under the name American Airlines, Inc., with headquarters at Wilmington, Delaware, and began to specialise in transcontinental operations. Routes were flown between New York and San Francisco and Los Angeles ; the hub of the A.A. network was the town of Tulsa, whence branch routes radiated to the south-western communities of North America. Smith has always remained true to his home state, Texas.

By the time the war was over American Airlines had earned heaps of money with contracts for military transportation. It had also been able to gain experience in overseas operations, and Smith had consequently—as stated above—acquired the share majority of American Export Airlines in 1944, and baptised it American Overseas Airlines.

He had an advantage over Trippe in that the A.A. network, contrary to that of P.A.A., did not end at the frontiers of the U.S.A., but provided extensions of the North Atlantic routes, with numerous branch airlines criss-crossing the entire North American continent. And because Smith really knew something about organising airlines, he became a natural rival, almost to the point of being enemy No. 1 of Pan American Airways.

North Atlantic networks of P.A.A., A.O.A. and T.W.A.





Transcontinental and intercontinental network hitherto operated by American Airlines System.

In acquiring A.O.A. he simultaneously acquired this carrier's *spiritus rector* in the person of a friend he had cultivated during his career with the Army Air Transport Command. And thus we meet again with an old acquaintance, namely the former Captain H. R. Harris, who in 1927—after having failed to make good in the cotton business—was responsible for the origin of Pan American-Grace Airways and Pan American Airways. The former captain had since been promoted to Brigadier-General in the U.S. Army Air Force, and had become Vice-President and General Manager of A.O.A. He had left P.A.A. and entered the camp of the enemy.

Co-founder of P.A.A., founder, Vice-President and General Manager of A.O.A.—is it unsafe to guess that Mr. Harris is perhaps the other co-founder of the Pan American-American Overseas consortium ?

*

We have named the two contracting partners behind the Pan American-American Overseas merger.

We shall now attempt to answer the second question : what is the ultimate goal of this contract ?

Under the title "The Shark in the Goldfish Pond—or the application of P.A.A. for domestic routes," it was shown in the September, 1948, issue of this magazine how Juan T. Trippe has endeavoured to defend himself against the sharks in his own goldfish pond, the North Atlantic.

His logical train of thought probably ran as follows : Up to 1939 I had a monopoly on U.S. overseas air traffic. Today I no longer have this monopoly. But why is that the C.A.B. wishes to exclude me from the U.S. domestic network ? My direct competitors, A.A. and T.W.A., fly foreign and domestic routes ; they operate intercontinental and simultaneously transcontinental services. What's good for one is good for another : I also demand permission to fly U.S. domestic routes.

And thus Mr. Trippe filed an application in March, 1945, with the C.A.B., asking for domestic route certificates. A number of obstacles lay in his path. To start with, almost all the U.S. domestic operators—for once that they were all in agreement—arose as one man against P.A.A., denouncing this carrier as an undesirable invader. Besides this, the C.A.B. felt no urge to plague the harassed inland operators with a new and powerful competitor. Officially, P.A.A.'s application kept the C.A.B. busy up to July 19th, 1948, and it is not yet officially known how the matter was settled. Generally speaking, it can be said that Trippe has not been very successful with this application.

Under these circumstances, he first tried to buy up T.W.A., which he has not yet succeeded in doing by friendly means. And thus it may be that his former co-worker and later rival, General Harold R. Harris, came almost as a messenger from heaven—this provided our assumption that Harris was the other partner is accurate.

And then granted that—according to the statements by the heads of P.A.A. and A.O.A. —the merger of the two carriers will be accompanied by all kinds of advantages, such as better exploitation of the organisation, operating economies, advantages over foreign competitors... there is nevertheless something more behind it all.

First of all, how did it happen that American Airlines was ever prepared to yield 61.9 per cent. or 1,082,445 shares of its subsidiary, A.O.A. ? That everybody was not in agreement with this decision is illustrated by the resignation of the Chairman and co-founder of A.O.A., John E. Slater. Though he has resigned to show his disapproval, he has all the same remained as Vice-President of American Export Lines, which possesses 20.3 per cent. of A.O.A.'s shares and is still the second largest A.O.A. shareholder. Why is it that A.A. yielded its A.O.A. stock when, though it had lost about $1,700,000 with this subsidiary in 1947, earned about $1,100,000 with it in the first ten months of 1948 ?

Such questions can be answered without risk by pointing out that the parent company, American Airlines, has had enough trouble with its domestic operations as a result of the crisis. During the first nine months of 1948, A.A. lost near to $4 million. To this comes the fact that it has to meet certain obligations in 1949 on behalf of the subsidiary, A.O.A., and among these obligations is the forthcoming acquisition of eight Boeing "Stratocruisers." The latter call for around $15 million, which explains the ominous sentence in the release of December 12th : "... the difficulty of securing the additional capital which will be required for the future." President C. R. Smith needs additional capital for his own carrier, which, though it was able to acquire a bank loan of $7,500,000 in 1947, lost nearly three million during the same year, to which it is likely that a further loss of at least $4,000,000 will have to be added for 1948.

C. R. Smith, Chairman of A.A. and the strongest man in the U.S. domestic airline field, surely likewise came to a logical conclusion when he closed this deal with P.A.A. : I cannot be the life of the party at every party ; I cannot simultaneously be the strong man at home and overseas. I have to choose one or the other field. Naturally, Smith quit the field which did not allow him to lead and would compel him to shoulder weighty burdens.

And Pan American Airways—why did it take over A.O.A. ?

It is probable that Trippe realised that his desire to obtain a slice of the U.S. domestic airline business was, after all, not meeting with any loving response from the C.A.B. He, too, confined himself again to his own special field, the operation of routes outside the U.S.A. By purchasing through friendly negotiation the control of its main competitor on the North Atlantic, Pan American did not only rid itself of a strong rival and expand its field of trade, but furthermore acquired a natural ally in the parent company, American Airlines—still the biggest U.S. domestic operator.

P.A.A. killed two birds with one stone. Because American Airlines, Inc., through an exchange of stock, has become a major shareholder in P.A.A., the latter—at least morally—obtains inland routes of its own. In theory, its network still halts at the frontiers of the U.S.A., but in practice it now extends from coast to coast over A.A.'s certificated routes. It seems logical enough that A.A. ticket agents will in future sell only P.A.A. tickets for overseas trips, just as it is clear that P.A.A.'s world organisation will do all in its power to give business to its new big shareholder, A.A.

We are faced with the fact that this merger of Pan Pan American Airways and American Overseas Airlines—indirectly American Airlines—has created a globe-girdling civil aviation system.

That is the ultimate goal of the contract.

*

The effects such a civil aviation system may have on the other U.S. carriers should not be underestimated.

One only needs to take the example of T.W.A.—which is now faced with a single and very mighty U.S. rival on the North Atlantic and a likewise newly-reinforced competitor in the transcontinental field—to see that there is every reason for scepticism. This company has been struggling for almost two years against difficulties of all kinds, and its financial resources are under a severe strain. If Howard Hughes, T.W.A.'s major shareholder, has hitherto refused to accept P.A.A.'s offers, then he does not need to expect to see new offers coming in for quite some time. He is no longer a danger to P.A.A. and A.A.

And United Air Lines ? In the transcontinental field this carrier is facing competition from A.A. and T.W.A. It is perhaps healthier than T.W.A., but certainly weaker than A.A. Since the war it has been flying a Pacific route to Honolulu, and has in this respect become a competitor of P.A.A. But because it has also been reporting annual deficits, it will have to prepare for coming to some sort of an understanding with the two mighty competitive concerns.

T.W.A. and U.A.L. aside, there are no grounds for the assumption that the new merger must be to the detriment of all U.S. domestic operators. On the contrary, Presidents Trippe and Smith anticipate, in addition to economies, increased revenues ; and these two carriers' stronger financial position can also animate the smaller operators' business. A company like Eastern Air Lines, which offers both A.A. and P.A.A. natural connections with the south-eastern part of the country and is a perfect example of how an airline should be run, cannot be endangered in any way.

Viewed collectively, therefore, the effects of the merger on U.S. domestic operators rather tend to appear as commercially beneficial. The frequently-mentioned U.S. anti-trust legislation hardly enters into the picture, as Trippe and Smith evidently do not wish to set up a trust organisation. It is a joining of two forces.

*

The case takes on a new appearance with respect to international civil aviation, particularly the North Atlantic operations by non-American airline companies.

In the joint P.A.A-A.O.A. release of December 12th, Trippe referred to the fact that foreign-flag airlines have increased the proportion of traffic carried by more than 50 per cent. in 1948. It is clear, therefore, that he wishes to launch an offensive against foreign-flag competition.

Between July and December, 1947, the three U.S. carriers flying the North Atlantic—P.A.A., A.O.A. and T.W.A.—managed to seize 71.2 per cent. of the entire passenger traffic, so that the remaining seven airlines flying over the area—all European, except for one Canadian—had only 28.8 per cent. If these companies increased their traffic by 50 per cent., then it would mean they had about 43 per cent. of the North Atlantic trade during 1948. However, Trippe seems to be exaggerating the blackness of the picture, since other reports state the European share to have been around 25 per cent.

No matter how high the share is, it disturbs Trippe. He knows perfectly well that if P.A.A. makes it clear that it wishes to fight foreign competition in the interest of U.S.-flag business, then he can count on the backing of the Civil Aeronautics Board, thus the U.S. Government.

For instance, P.A.A. would be able to strike the first blow when it receives its Boeing "Stratocruisers," of which delivery is expected to follow shortly—provided, of course, that these airliners really possess the qualities claimed by the manufacturer. P.A.A. has 20 "Stratocruisers" on order, A.O.A. has eight, so that the United P.A.A.-A.O.A. fleet could—at least on paper—enter the fight with 28 new airliners sooner or later.

As far as the reaction on the part of the European carriers is concerned, well... that is their affair. If they continue to wage merciless war against each other, splitting their forces and not uniting ; if they do not combine and set up joint schedules—then they will only be facilitating matters for Pan American.

However, if they copy the example of P.A.A. and A.O.A., and also come to a common understanding, it is probable that the quality of their organisations, aircraft, crews, and service on board will take a turn for the better ; moreover, it is evident that the Europeans will always prefer their national carriers, equipped with national crews and offering national service. Our thoughts go first to the proven trans-Atlantic services of the Dutch, French, Scandinavians and Belgians. The question of the British must be viewed from another angle. It must not be forgotten that the British worked together with Pan American already before the war, and even if they cannot do that today, the particular structure of their air transport organisation makes it so that everything cannot be lost. On the one hand, the British airlines are protected by the Sterling barrier, which prevents passengers from migrating to P.A.A. ; on the other hand, the operating losses suffered by the British corporations do not matter so much, since they are covered by the taxpayer.

*

Pan American World Airways is today the most powerful airline company in the world.

This can easily be expressed in figures. If, according to an estimate by the IATA Director-General, the scheduled airlines of the world did about $1,000 million worth of business in 1947, then—according to the balance sheet—$135 million can be attributed to Pan American alone. In its 21 years of existence, P.A.A. has built up a global network, a mighty organisation, founded subsidiaries all over the world, and justifiably calls itself the "world's most experienced airline." The heritage of its one-time major competitor, the German Lufthansa, fell into its lap. It is now united with its biggest post-war rival, American Airlines. It has at its disposal a well-assorted air fleet, trained crews, a proven technical service, and a travel-agency organisation which is unique in civil aviation, perhaps even in shipping.

P.A.A. carries the Stars and Stripes around the world, backed by the U.S. Government and—what is not without importance—U.S. finance.

With these means at its disposal, P.A.A. is also building hotels, though mainly in South America for the time being. And if it wished tomorrow to build such hotels in the ravaged cities of Europe ? Perhaps many countries would welcome the idea ; perhaps P.A.A. could, in that respect, contribute towards the reconstruction of Europe, if...

If Juan T. Trippe, today the world's most powerful man in the airline business in the next few years sees his way to becoming not only an influential and feared man, but also a popular man with his competitors.

Already having cast global route-nets, he is now in a position to haul them up with a big catch.

E.E.H.

Microplanes

Believe it or not, the Americans have discovered a new superlative! Previously, it had always been their aim to attain the upper limit of possibility; they built the highest skyscrapers, the roomiest automobiles, the most gigantic factories and... the largest aircraft in the world.

Is it the fault of the wartime rationing cartoon whimsy of a hungry man being advised by a waiter to raise a pea on his plate to find the steak he had ordered? One thing is sure, that the U.S.A. has discovered the charm of the "tiny" and "tiniest." It will not be long before United States designers awaken to the new possibilities of the infinitesimal in aircraft construction, and start evaluating microplanes in every respect.

A few months ago we acquainted our readers with the "Weebee," a tiny aircraft weighing less than its prone pilot lying astraddle the top of the fuselage.* Since then, the "Weebee" has really flown; not very high and not very far... but nevertheless flown.

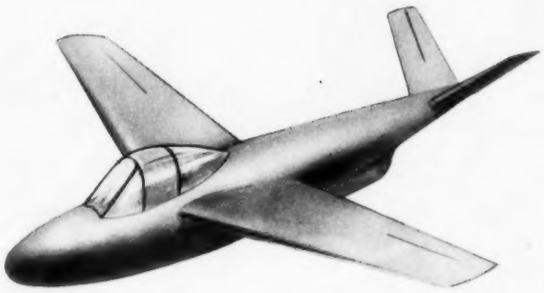
Airmindedness increasing such as it is, and wealthy venturers delighted to find new ways to sidestep taxes by hazy capital investments, we may see the sky full of "Weebees" in less time than it takes to tell.

And pity the poor airline pilots! Such as the TWA captain who recently heared an angry crunch while taxiing over a little Piper "Cub." Luckily the "Cub" was targeted zero-zero, and the airliner ground to a stop with the little aircraft's fuselage precisely beneath it. The "Cub's" wings were sheered off, but its pilot not even scratched.

But even more ominous than a sky full of "Weebees" is the prospect of microscopic personal jets screetching about willy-nilly; a potentious possibility that Major C.C. Moseley, owner of Grand Central Airport and Cal-Aero Technical Institute in California, seems intent on making a reality. A few months ago it was only a sketchbook dream, devised to stir the imagination and enthusiasm of the major's several hundred Cal-Aero students. But it would seem that this dream got out of control, for Cal-Aero students are now firmly resolved to put the United States' first midget jet-personal aircraft into the air before the year is over. Blueprints and a mock-up are completed, a classroom experiment with turbo-jet burners has yielded a workable engine, and Moseley's students will be busily "pounding tin" in the assembly of the aircraft by the time this is read.

Judging from the artist's sketch, the end result will be a fair approximation of a jet-propelled flying slipper... doubtlessly fully equipped with shoe-horn or boot-strap to squeeze the pilot into the cockpit if he wishes to take off immediately after a full-course breakfast. It is described as a micro-synthesis of everything the big jets possess, even to a bicycle landing gear.

* INTERAVIA, Review of World Aviation, Vol. III, No. 11, p. 609.

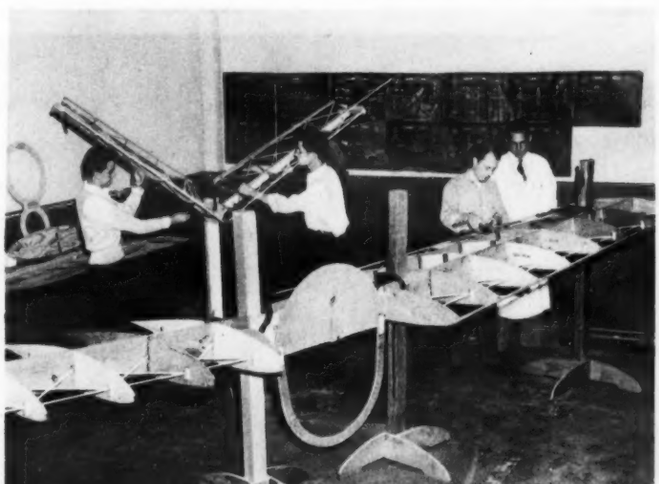


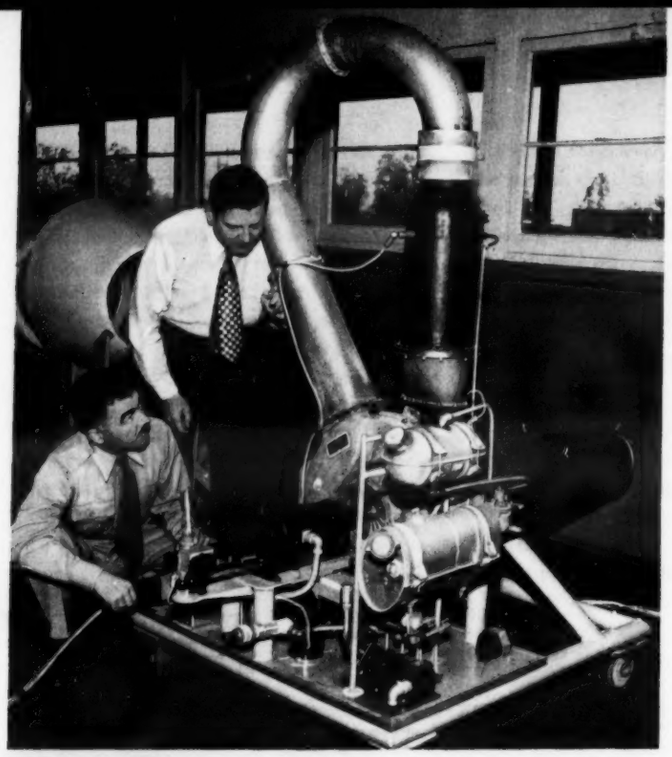
The single-seater XLC-1 micro project of Cal-Aero Technical Institute, California, strongly resembles a scaled-down Beech "Bonanza."

Estimates of thrust from the tiny, single-burner turbo-jet, which is now being re-designed to still smaller dimensions and weights, give the midget 250 m.p.h. top speed, a range of 325 miles on 75 gallons of fuel at cruising speed, a rate of climb of 1,380 feet per minute, and a ceiling of 35,000 feet.

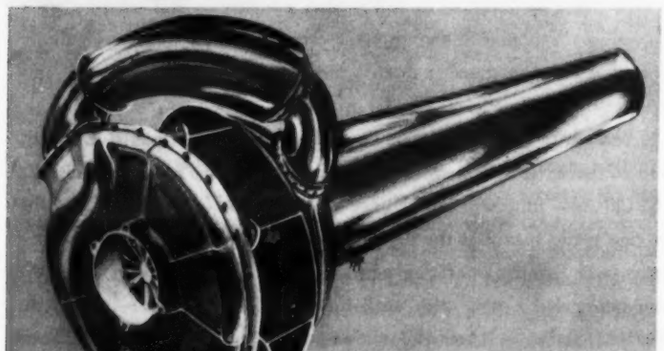
And all this with an aircraft measuring only 17 feet 1 inch in length and 20 feet 10 inches in span! In reality, there is no reason to presume the Cal-Aero mite will not achieve this performance, provided... the engine really furnishes the design output. Should it do as much, and even over lengthy operating periods, then imagine the concern of the doddering old timers who until now have lived fairly ordered lives buzzing about in their sedate—and by then obsolete—propellered aircraft, or chatting with their passengers while the autopilot and co-pilot conduct a prosaic transcontinental run! No telling at what mo-

A wooden mock-up is also built for the XLC-1—just as for a "real" aeroplane.





A class-room experimental model of a jet engine with vertical burner (above) yielded a workable engine for the XLC-1 microplane (below). Test bed trials have been conducted —but no data on efficiency or thrust have yet been released.



Cal-Aero's curriculum includes wind-tunnel tests—this time on an aircraft of its own conception.

ment a jet-propelled midget might bolt down from "35,000 service" with its anoxia-happy pilot busily trying to translate miles-per-hour into high Mach numbers ! There will be no peace left in the airspace if such jokes ever get out of hand.

Imagine, if you will, the psychiatric reaction of a greying DC-4 skipper gazing dreamily at the cumulus to his left and suddenly seeing a slipper-jet pilot streak by with his thumb to his nose. Probable, too, is that the advent of the jet microbe will call for serious engineering conferences and the installation of direct-below-vision windows in cockpit floors to permit close scanning of runways and taxi strips infested by such insects.

In view of its butterfly empennage, the new midget jet resembles, at the first brief glance, the four-seater Beech "Bonanza." Result ? A flood of complaints from "Bonanza" owners demanding that Walter Beech tell them how it is that other "Bonanza" owners continually overtake them by a good 100 miles per hour !

* * *

Cal-Aero is not the only U.S. centre interested in designing micro-planes. It is already some time since we first learned of the activities of West Engineering Co., of Los Angeles, a firm which has developed baby turbo-jets from reciprocating engine superchargers.*

The original intention was to develop a four-seater personal aircraft which, powered with two of these baby turbo-jets, would attain a top speed of 360 m.p.h. Apparently this project was all the same

The twin-jet project of West Engineering Co., of Los Angeles, is expected to top 350 m.p.h.

too optimistic, for until now the firm does not appear to have succeeded in squeezing out the requisite 400 lbs. thrust from the engine. In any case, the latest plans—possibly part financed by Eastman Jacobs (who is widely known for his development of the laminar-flow wing)—speak of a two-seater midget personal plane. Two single-burner turbines are expected to give it a top speed of 400 m.p.h. and enable it to cruise at 375 m.p.h. over a range of 500 miles at 4,000 feet. The two occupants sit almost side by side in seats placed slightly obliquely to one another, an arrangement requiring a minimum of fuselage width. Of the 2,750 lbs. gross weight, 1,000 lbs. is made up by the fuel. For the rest, designer Ed. West anticipates a take-off run of 2,300 feet to clear a 50-foot obstacle, and a landing speed of about 70 m.p.h.

Should the project ultimately be realised (and provided the engine lives up to its constructor's expectations), it is likely that the West midget jet will be first unveiled to the public on the occasion of the annual National Air Races at Cleveland, Ohio.

Until then, however, the private flyers' sky will continue to give refuge to the good old propellered aeroplane... which is fast enough anyhow !

* INTERAVIA, Review of World Aviation, Vol. III. No. 5, pp. 286-287.

The XVIIIth Salon de l'Aéronautique in Paris

29TH APRIL TO 15TH MAY, 1949

1909—1949 . . . a period of forty years between the first international aviation exhibition in Paris, and its eighteenth return staging. Thus when the Paris Salon opens its portals on the 29th April, it will simultaneously be celebrating a jubilee.

For the exhibitor, a jubilee means an obligation. Hence it may be deduced that this year's show will have a grander background than previously. Besides the usual stands for small and medium-size aircraft, engines, equipment and components in the traditional "Grand Palais," there will be additional exhibits on the adjacent Esplanade des Invalides. On this historical spot, which was the scene of the 1889 World Fair, miniature airport installations, large airliners and many other things will be on show.

Finally, the programme includes a nocturnal festival in the shape of a big ball at Orly airport. The French know how to organise this sort of thing. With special aircraft, a kind of rally of the international airlines, celebrities from all over the world are to be brought to Paris.

That will be the background.

And the actual exhibition ?

It is likely that the host will not shine so brightly this year. The French aircraft-manufacturing industry, which exhibited many promising projects at the last Paris Salon in 1946, is now having to struggle to keep its head above water. It is suffering because of the political situation in its own country and indirectly because of the current political trends in Europe. In consequence, the foreign aircraft manufacturers would have to dominate the picture—at least theoretically.

It is known that the British industry—in view of its Government's export policy and its own desire to export—will again be strongly represented. It is also known that the newly-awakening Italian industry has reserved a good number of stands. Finally, we know that the Swedes, Dutch and Czechoslovaks will be present. And the Americans ?

In 1946, on the occasion of the 17th Paris Salon, they were content to effect a polite *acte de présence*. They were aware of the approaching crisis in aeronautics and—quite wrongly—did not believe at that time that a new market would materialise. Thus visitors found only a few U.S. stands, representing Lockheed, Douglas, United Aircraft, Curtiss-Wright, Bendix. This time ?

In the meantime the U.S. aircraft industry has managed to overcome its crisis. Since the last Paris Salon, Lockheed, Douglas, Curtiss-Wright and United Aircraft have been able to export their goods to all corners of the globe. Or will anybody deny that U.S. airliners are being flown in Europe, Africa, India and Australia ?

And thus we come to the decisive question for the Paris Salon : Who will come, and is it worth while coming ?

The first half of the question cannot be answered at the present time of writing. Announcements are coming in every day.

But whether it is worth while exhibiting in Paris ?

Paris is still the same foreign centre *par excellence* ; a world cross-roads. No aeronautical exhibition in the world is so well attended by representatives of civil and military aviation as the Paris Salon. Not only curious visitors shuffle through the Grand Palais ; there are to be found many really interesting people, and occasionally good customers, too.

The Paris Salon itself is only a motto, a pretext. But the hotels, restaurants and all the many meeting places in the French metropolis will, on this occasion, be swarming with crowds of people with whom business can be done sooner or later.

For this reason we believe that this year's show in Paris will once again be a success.

Photos taken at the XVIIth Salon de l'Aéronautique in Paris.

Zero minus Five?

Treaties in the Era of Aerial Warfare

Test of nerves

It is not necessary to read every word of the newspapers to observe in what kind of a "phoney peace" we are living ; it suffices to page quickly through any illustrated weekly—pages one to five : Berlin Air-Lift, photographs of English, American, French and Russian officers, dare-devil pilots, hazardous night landings, evacuated mothers carrying their children on their backs ; page six : a cheerful interruption of this subject by the marriage of a boxer to a film star ; but then, pages seven to fourteen : Chinese Nationalists fleeing southwards, open cattle trucks packed with wounded soldiers, ravaged towns, a three-year-old orphan with Asiatic features looks bewildered as it waits for the last outbound aircraft to land, General X and his staff discuss plans for evacuating the city of Y, Communist forces advancing. And so it goes on. One page depicting normal life is followed by three or four showing mobilised soldiers, large-scale manoeuvres, displaced persons, guided missiles, and so on. Just about the only comforting features are the advertisements for whiskies, gins and . . . Bromo Seltzer. All as if there were no such thing as the United Nations Organisation . . .

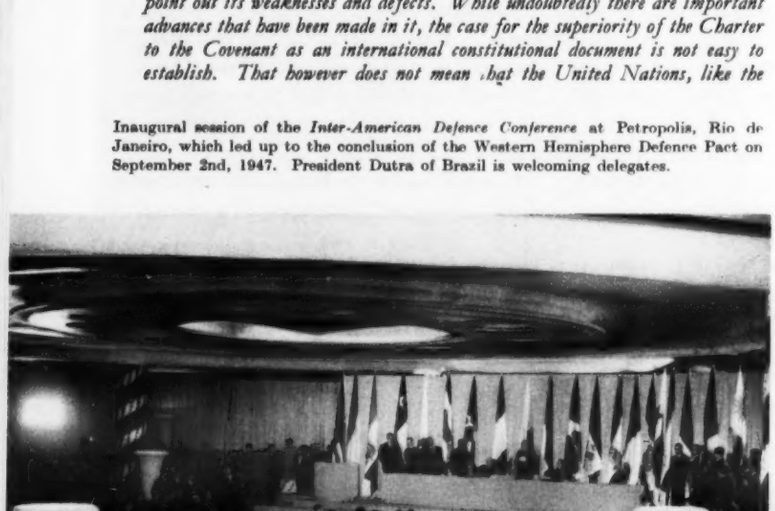
It is not without interest now to look back on how the fathers of UNO prophesied the present-day situation three years ago. The authors of the basic commentary on the Charter of the United Nations, Leland M. Goodrich and Edvard Hambro, attended every conference on the establishment of UNO, Goodrich as Director of the World Peace Foundation and Hambro as a member of the Norwegian delegation. In their commentary, published on January 30th, 1946, they wrote the following on the future of UNO :

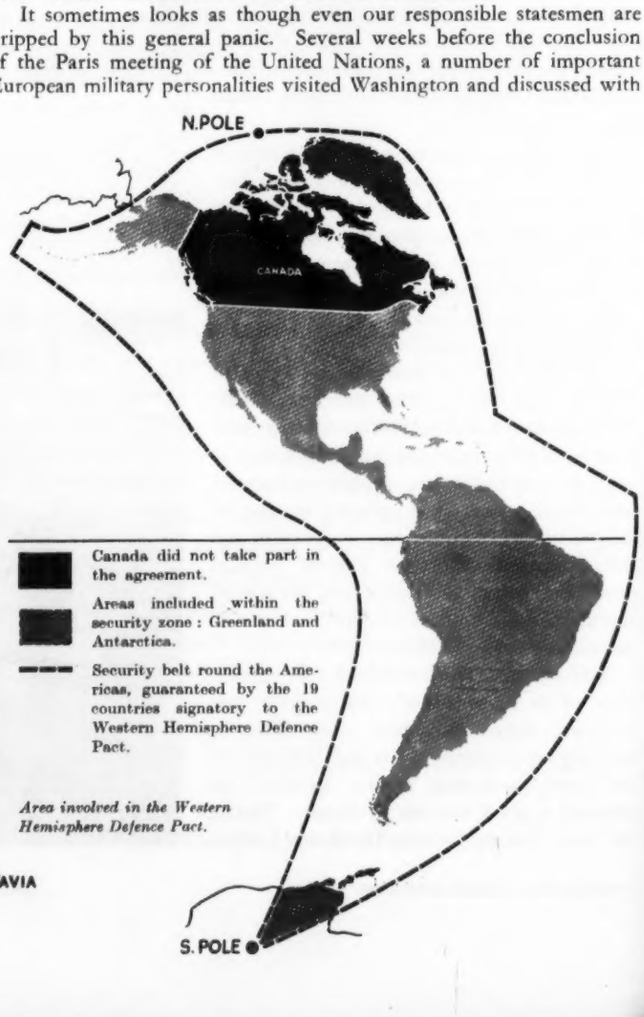
> *"It is easy enough to criticise the provisions of the Charter, and to point out its weaknesses and defects. While undoubtedly there are important advances that have been made in it, the case for the superiority of the Charter to the Covenant as an international constitutional document is not easy to establish. That however does not mean that the United Nations, like the League of Nations, must fail. The League failed largely because it did not succeed in getting sufficiently broad support from peoples and governments. The United States never joined ; the Soviet Union did not join until very late ; other states, though members, failed to give it full support. The Charter of the United Nations has received wider acceptance. All the nations which were associated together in World War II have become members, and we can hope that with the war experience fresh in their minds they will co-operate in good faith and strong purpose for the maintenance of a long period of peace. But, again, this will not come to the world as manna from heaven. Such successes as come to the U.N. as an organised effort to keep the peace and promote the general well-being of peoples will be entirely due to the steady and intelligent efforts of peoples and their governments . . ."*

And today ? The public seems convinced that this attempt has failed in its purpose. Nervous restlessness is urging mankind towards new ways to salvation, whereby serious and less serious endeavours usually stem from the same considerations. The Amsterdam negotiations for establishing the United States of Europe—the Nottingham chimney-sweep, Arthur Cuttris, who wanted to visit Stalin and acquire a lasting peace—the American millionnaire, Clarence Booth, who is building himself a "guaranteed atom-proof" house on the coast of New Jersey—Citizen of the World Garry Davis, who is asking everyone to give up his passport and nationality ; as varied as these things may appear externally, internally they can all be brought to a common denominator : the worry that UNO has failed, and that a state has been reached which must sooner or later lead to the outbreak of hostilities.

It sometimes looks as though even our responsible statesmen are gripped by this general panic. Several weeks before the conclusion of the Paris meeting of the United Nations, a number of important European military personalities visited Washington and discussed with

Inaugural session of the *Inter-American Defence Conference* at Petropolis, Rio de Janeiro, which led up to the conclusion of the Western Hemisphere Defence Pact on September 2nd, 1947. President Dutra of Brazil is welcoming delegates.




N.POLE
CANADA
S. POLE
Canada did not take part in the agreement.
Areas included within the security zone : Greenland and Antarctica.
Security belt round the Americas, guaranteed by the 19 countries signatory to the Western Hemisphere Defence Pact.

Area involved in the Western Hemisphere Defence Pact.

Allied for fifty years : The Foreign Ministers of the five contracting countries signed the Treaty of Brussels on March 17th, 1948, at the Palais des Académies in Brussels. The five countries are Great Britain, France, Belgium, Holland and Luxembourg. The photo shows British Foreign Secretary Ernest Bevin signing.

Last page of the Brussels Treaty of March 17th, 1948, showing the signatures of the five Foreign Ministers : *Henri Spaak* (Belgium), *Georges Bidault* (France), *Joseph Beck* (Luxembourg), *Baron van Boetzelar* (Holland), *Ernest Bevin* (Great Britain).

the U.S. military leaders American plans for military assistance to Europe. On December 11th, 1948, President Evatt of Australia made a dramatic appeal in the Palais de Chaillot to the nations not to allow UNO to die, but to defend as it is our only hope. But in Washington's Pentagon Building at the beginning of last December, talks went on between : the Chief of U.S. Army Staff, General Omar Bradley ; the Deputy-Chief of Imperial Staff, Lieutenant-General Sir Kenneth Crawford ; the French Under-Secretary of State for Air, Jean Moreau ; the Secretary of the U.S. Air Force, W. Stuart Symington ; the Chief of Staff of the Italian Army, General Efisio Marras ; Air Marshal Sir Ralph Cochrane, Air Officer Commanding-in-Chief, R.A.F. Flying Training Command ; F.G. Manning, Director-General of Aircraft Supplies at the British Ministry of Supply ; and numerous high officers of all service branches, representing the countries interested in the projected North Atlantic Defensive Pact : U.S.A., Canada, Great Britain, France, Belgium, Holland and Luxembourg.

Treaty of Rio de Janeiro, Western Union, North Atlantic Defensive Pact, the establishment of chiefs of staff committees—are these not all reasons for really serious thought ? Is it possible to do otherwise than connect them with imminent events of a belligerent nature ? It used to be the diplomatic practice to be content with general promises of mutual aid, and only to start joint staff discussions at, so to speak, zero minus five. Must we therefore deduce from the military discussions in Washington that it is actually zero minus five ? Fortunately, no. It is a new diplomatic procedure which has been made technically indispensable by the Air Age, but it in no way signifies a dramatic culmination of the general political situation. Why ?

Alliances yesterday and today

In May, 1882, when Germany, Austria and Italy concluded a tripartite pact against Russia and France, they agreed on the following in Article 5 of their treaty :

> *"Should the peace of one of the High Contracting Parties be threatened under the conditions which are mentioned in the foregoing articles, then the High Contracting Parties will agree in good time on suitable military measures for eventual co-operation."*

Thus it can be seen that countries were content to give each other political promises of later military co-operation, and delayed the settlement of the technical details until the *casus foederis,* the time when it was necessary to implement the treaty. International diplomacy followed this practice up to the outbreak of World War II. The well-known Article 16, on sanctions, of the Covenant of the League of Nations (which came to public notice notably during the Italo-Abyssinian conflict) states in paragraph 2 :

> *"It shall be the duty of the Council* [*in the event of an unprovoked attack by one country on another*] *to recommend to the several governments concerned what effective military, naval or air force the Members of the League shall severally contribute to the armed forces to be used to protect the covenants of the League."*

On the other hand, the United Nations Charter takes the changed situation into account. As regards plans for the application of armed force, the Security Council shall be assisted by a Military Staff Committee (Article 46). The organisation and functions of this Military Staff Committee are described in detail (Article 47). Above all, however, it is planned to have an air force in constant readiness. Article 45 states :

> *"In order to enable the United Nations to take urgent military measures, Members shall hold immediately available national air-force contingents for combined international enforcement action. The strength and degree of these contingents, and plans for their combined action, shall be determined . . . by the Security Council with the assistance of the Military Staff Committee."*

It goes without saying that the importance of such military staff talks, as a preparation for joint operations, was recognised by military experts long before World War II. Joint discussions of British and French staffs made it possible to stem the advance of the Germans during World War I; and during the inter-war period, France repeatedly—although in vain—urged a suitable supplement to the security clauses of the League of Nations Covenant. But it was not until after the air attacks of the second world war that politicians finally realised that treaties were completely valueless unless accompanied by concrete military measures of preparation. During World War II, consultations between American and British commanders led to the establishment of the Combined Chiefs of Staff. Without it, the victory of the Western Allies might well have been prejudiced.

In view of the relative simplicity of earlier weapons and the comparatively long time available for drawing up the reciprocal plans of operation, one could hope to merge two or more national armies into an organic unity during the course of a war. Nations used to be proud of their ability to mobilise their forces within three or four days. Nowadays, in the era of aerial warfare, it might be time, after three or four days, to start negotiating an armistice. This recognition is reflected in the Treaties of Rio de Janeiro and Brussels. In it should be sought the reason for which the negotiations for the North Atlantic Defensive Pact had to be started off with military staff talks.

The treaty system

One should not deduce from the conclusion of American and European security treaties that the nations are turning their backs on UNO. The U.N. Charter grants member nations the right of individual or collective self-defence until the Security Council has taken the necessary military measures (Article 51) and authorises the nations to conclude regional security pacts, provided that these are consistent with the purposes and principles of UNO (Article 52).

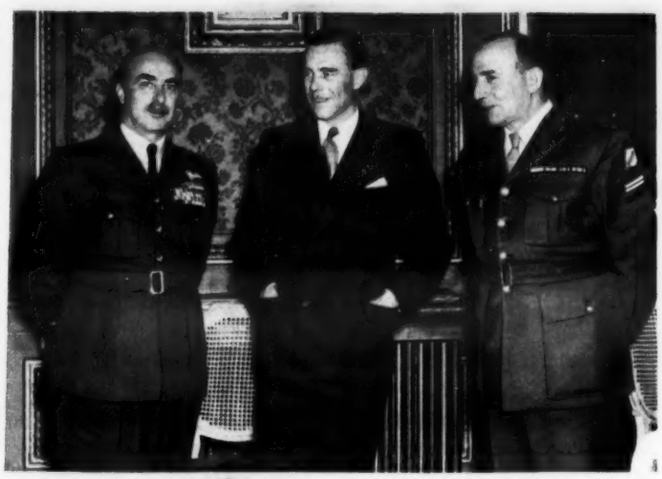
The establishment of these articles was dictated by the consideration that not all member countries in every part of the world could be ready for immediate attack. Moreover, the U.S.A. made its membership of UNO dependent on the validity of regional security pacts, for it is pledged to the Monroe Doctrine which aims at such co-operation among all the American countries.

*

And thus we have been witnessing, during the past year, the evolution of a group of treaties which makes increasing provision for the modern requirements of preparedness.

On September 2nd, 1947, nineteen American countries, signatory to the Western Hemisphere Defence Pact signed at Rio de Janeiro,

Conference of the Western Union countries at The Hague. At the head of the table, wearing a striped suit and glasses, can be seen Henri Spaak : second on his right is Georges Bidault ; and two further on, Ernest Bevin. Opposite them are the Dutch and Luxembourg delegates.



Military experts of the Western Union meeting in Brussels, October, 1948. From left to right : Air Marshal Sir James Robb, Vice-Chief of the R.A.F. Air Staff, who has been appointed Air Commander of Western Union ; Colonel Defraiteur, Belgian Minister of Defence ; General de Lattre de Tassigny, who is to head the Western Union Ground Forces.

formally pledged to take joint action to defend the Western Hemisphere against outside attack, and laid a safety belt about the two Americas, whose infringement would be regarded as a *casus foederis* of the pact. This security zone extends from Pole to Pole, and embraces Canada, Alaska, the Aleutians, Greenland, the Faulkland Islands, the South Orkneys, and the American sector of Antarctica. During the discussions several South American countries sought to include wider economic issues. But the U.S.A. clearly wanted to confine the negotiations to questions of military defence, and left no doubt as to the fact that it did not wish to have this purely military pact swamped by other considerations. And the fact that this treaty should not be confined only to America can be deduced from the speech by President Truman on September 2nd, 1947, at Petropolis, Rio de Janeiro, on the occasion of the Inter-American Defence Conference which led up to the above pact. He makes an unmistakable allusion to an ultimate Western alliance with Europe :

> *"This Western Hemisphere of ours is usually referred to as the New World. That it is the New World is clearer today than ever before. The Old World is exhausted, its civilisation imperilled. Its peoples are suffering . . . Their hope must lie in this new world of ours . . . It is for us, the young and the strong, to erect the bulwarks which will protect mankind from the horrors of war—forever . . . United, we can constitute the greatest single force in the world for the good of humanity."*

*

Prior to the ratification and going into force of the Western Hemisphere Defence Pact—or Treaty of Rio de Janeiro—on December 3rd, 1948, there was the signature on March 17th, 1948, of the Treaty of Brussels by the Western Union countries : Great Britain, France, Belgium, Holland and Luxembourg. On July 21st, 1948, Major-General Lyman L. Lemnitzer and other U.S. service representatives arrived in London at the invitation of the Permanent Commission of the Western Union, to take part in the work of the Union's Military Committee. And by September 28th, 1948, the joint defence organisation of the five Western Union countries had a roof over its head. The Council of the five Foreign Ministers is now assisted by a permanent Western Union Defence Committee, which is responsible for production and armament of the contracting countries. This Defence Committee receives its military advice from, and has its directives issued by, the Western Union Chiefs of Staff Committee, under the Chairmanship of Marshal of the R.A.F. Lord Tedder (who is also chairman of the British Chiefs of Staff). The Chiefs of Staff Committee supervises the Western Union Military Committee, and the latter has an important offshoot in its Supply and Resources Board (which includes U.S. and Canadian observers). Also responsible to the Chiefs of Staff is the Western Europe Commanders-in-Chief Committee, whose Chairman, Field Marshal Viscount Montgomery, exercises no real command functions for the time being, but is ready to take up such functions at a moment's notice.

*

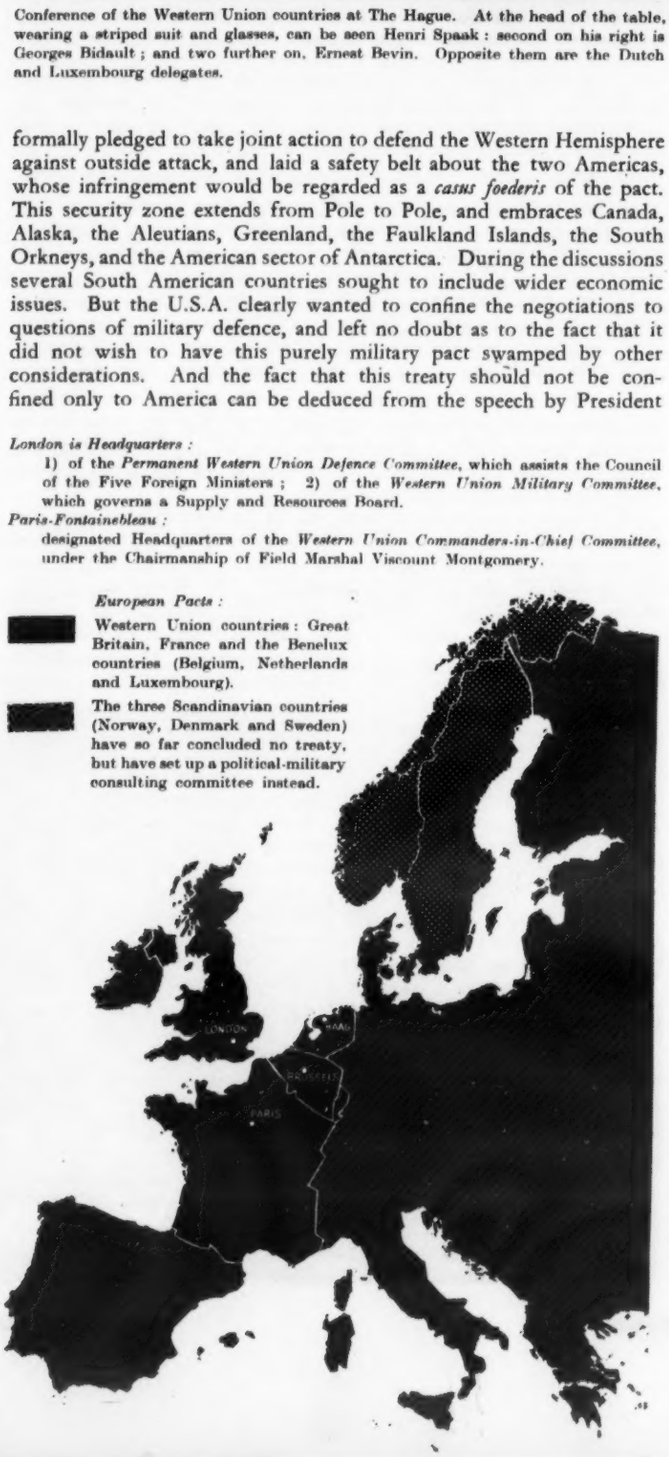
The projected North Atlantic Defensive Pact, which is being negotiated in Washington at the time of writing, will head the list of all these treaties. Canada, who did not participate in the Western Hemisphere talks in Rio de Janeiro, is taking part in the Atlantic Conference. Moreover, Denmark, Norway and Iceland are said to have been asked to participate by the seven countries taking part. (The final attitude of the Nordic countries, nevertheless, will probably depend upon the evolution or non-evolution of the Scandinavian defensive scheme, which is still very much in the balance in view of

London is Headquarters :

1) of the *Permanent Western Union Defence Committee*, which assists the Council of the Five Foreign Ministers ; 2) of the *Western Union Military Committee*, which governs a Supply and Resources Board.

Paris-Fontainebleau :

designated Headquarters of the *Western Union Commanders-in-Chief Committee*, under the Chairmanship of Field Marshal Viscount Montgomery.


European Pacts :
Western Union countries : Great Britain, France and the Benelux countries (Belgium, Netherlands and Luxembourg).
The three Scandinavian countries (Norway, Denmark and Sweden) have so far concluded no treaty, but have set up a political-military consulting committee instead.
LONDON
PARIS

The Projected North Atlantic Defensive Pact :
Area concerned in the Washington talks between the U.S.A., Canada and the five Western Union countries.

Countries whose participation is being considered : Denmark, Norway and Iceland ; also Portugal and Italy.

Swedish neutrality considerations.) Finally, there is talk of Portugal and Italy taking part.

Treaties have been or are being concluded, defence ministers are talking matters over, staff committees are establishing permanent offices, and everything would be perfectly fine if the picture were not dulled by certain criticisms of the combat readiness of the contracting countries. That the U.S.A. is up to date is beyond doubt. But how do matters stand with regard to the European allies ?

To arms

A perfect example of a "allied army" was that of the "Holy Roman Empire of German Nations," established in 1521, which was later reinforced to 40,000 men in view of the military successes of King Louis XIV of France, and was made up of contingents from numerous German countries. In principle, this army, nicknamed the "Speedy Empire Army," was only mobilised in the event of war, at which time every man had to swear to defend the Emperor and Empire. Poor training, lack of standardisation in armament and equipment, and exceptional top-heaviness, resulted in the combat value of this army sinking very low, to such a point that in the Eighteenth Century it was the laughing stock of all Europe. "The Speedy Empire Army" ultimately became known as the "Weedy Empire Army."

It comes as a harsh surprise to learn that the well-known English military critic, B.H. Liddell Hart, attributes almost the same deficiencies to the present armed forces of the Western Union nations. In an article entitled "What is the Military Strength of the West ?" (Picture Post, October 23rd, 1948) he explains that the combat value of the British and French armed forces is suffering under the "swollen establishment of non-fighting troops that are a universal product of wasteful war time organisation, which always tends to develop too much top-hamper and too large a 'tail'."

Liddell Hart describes how the indiscriminate mixture of army set-ups—militia, standing army, conscription—places obstacles in the way of standardised training, and then points out that even if these difficulties were ironed out, there would remain the equipment problem, which affects France most of all :

> "... *the equipment problem remains to be solved. At present, that is the worst deficiency of the continental members of Western Union, and even worse in the air sphere than on land. It is difficult to see how it could be met except by large-scale and early provision from the U.S.A., under a new military lend-lease plan.*"

Unless we are sorely mistaken, these questions very probably form the subject of the present Washington negotiations for the North Atlantic Defensive Pact, for it is clear that the most powerful U.S. Air Force would be valueless if it could not immediately find a corresponding ground organisation on the European continent—airfields, stocks of spares, ground servicing crews, and so forth.

*

This problem can become especially critical for countries adhering to the principle of neutrality. The sharp-witted Nordic journalist, G. van Uxkull, says in a recently-published article entitled "Is the Northern Union Ahead ?" :

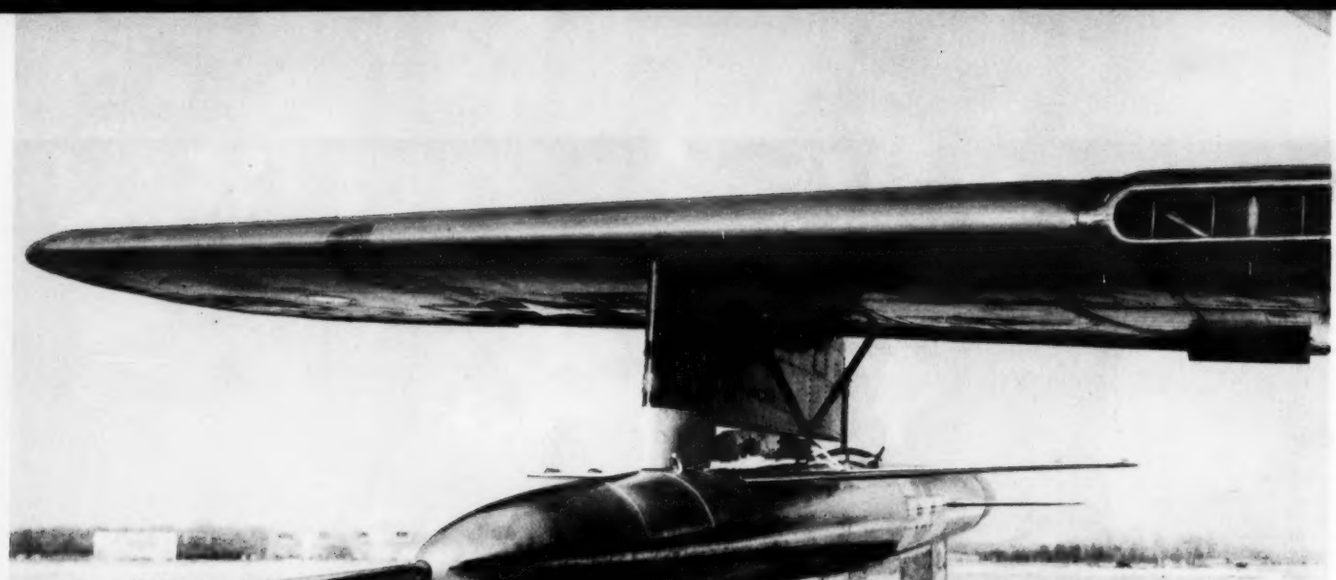
> "*Moreover, one asks oneself in Sweden whether the countries who so strongly urge alliances, do not over-estimate the practical value of such pacts in the era of total war.*"

And this is his conclusion :

> "*The fact that Sweden does not urge a formal pact may be regarded as exaggerated caution by some, though in this respect, too, one can apply what has been said above on the Western Union : that Sweden attaches greater value to the later action than to the present demonstration. For the practical purposes of a pact, it is the opinion in Sweden that, for the present, the committee composed of nine political and three military representatives of the three countries concerned—Sweden, Norway and Denmark—is sufficient for studying problems of joint Scandinavian defence.*"

It appears doubtful whether Uxkull's arguments will stand the test. It would seem that the typically modern alliance can no longer do without military staff discussions, accompanied by as quick and extensive standardisation as possible of training, equipment and production. The aircraft has set the tempo for the politicians.

The Scandinavian countries plan to conclude their own security pact, as Sweden's desire for neutrality opposes her adherence to the Western Union. The photo shows a meeting of the Foreign Ministers (from left to right) : Gustav Rasmussen, Denmark ; Oesten Undén, Sweden ; Halvard Lange, Norway ; Bjarni Benediktsson, Iceland.



Gorgon IV

Unmanned aircraft, equipped with remote or built-in control, are apparently being developed nowadays exclusively as carriers of destructive materials, as long-range missiles, and winged bombs. But far more interesting than the negative goal of this work is the positive research to acquire new knowledge and more efficient technical means. For this will not be in vain when civilisation takes a turn for the better and we can "finally live in peace."

Externally a winged bomb for long ranges, or a remote-controlled unmanned aircraft for target practice—the U. S. Navy designation on the fin, KUM-1, indicates as much: K = target-drone, U = utility, M = Martin, and 1 = first version—the "Gorgon IV" shown in the accompanying photographs, is a pure research instrument. What is its purpose? Another designation attributed to it is PTV-N-2, meaning "Propulsion Test Vehicle, Navy." And the engine which is being tested along with it, is a ram-jet built by Marquardt Aircraft Company,* the simplest conceivable medium for propelling an aircraft by means of fuel and air. It consists of a section of iron pipe, resembling for all the world a piece of stove pipe, 20 inches wide and seven feet long, with air entering in front, fuel being sprayed into the centre portion, and thrust-producing exhaust gases leaving the rear end. That is all.

The ram-jet engine has only one disadvantage. Under constant fuel consumption, it delivers great propulsive power at high supersonic speeds, but no power whatever when at a standstill (thus when being started), and only very little at subsonic speed. The "Gor-

* INTERAVIA, Review of World Aviation, Vol. III, No. 3, pp. 149-150.

gon IV" has therefore to resort to take-off assistance, and can only fly independently at extremely high speeds. However, it was purposely designed, under Navy order, to operate at subsonic speeds. For to control an aircraft travelling at near to sonic speed is no child's play ; and even a remote-controlled or automatically-controlled, slow-flying aircraft does not always obey orders. So why pile up difficulties ? On the other hand, no fuel-saving is effected with the "Gorgon IV." For a flight of only little more than ten minutes (which at 600 m.p.h. nevertheless signifies over 100 miles) 116 gallons of ordinary 80-octane gasoline has to be carried—still sufficient to keep some of the largest four-engined types aloft for the same amount of time.

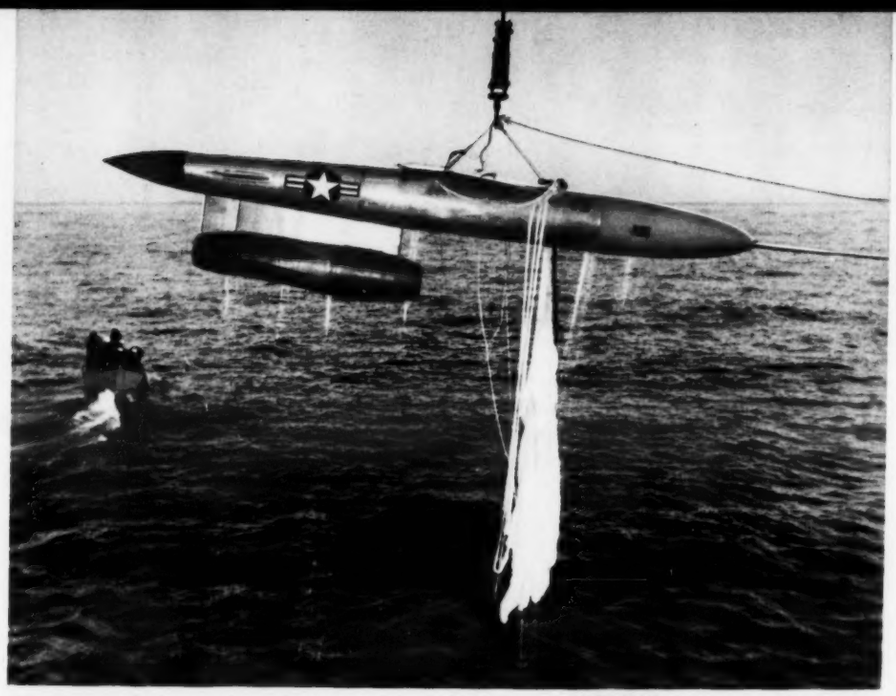
Apart from the power plant, the "Gorgon" has much in common with a very-high-speed fighter. The 22-foot-long fuselage has a thin swept-back wing of only 10 feet span and a likewise swept-back elevator unit. The fin, connecting the fuselage with the ram-jet, is located with the rudder beneath the rear half of the fuselage. Elevator and rudder control are exactly as for a piloted aircraft, but spoiler ailerons are used for lateral control. Gross weight of the vehicle is 1,600 lbs., 700 lbs. of which is the ram-jet fuel.

The pilot's job is carried out by an automatic control device, which can either be controlled by radio from a ground station, or preset to perform such normal flying functions as level flight, banks and turns. Should it start travelling too fast and approach sonic speed, drag brakes are automatically extended. On the other hand, there is no means of finely regulating the ram-jet. The "Gorgon" carries a full set of instruments for telemetering to a ground receiving station such data as speed, altitude, brake drag, controllability, engine operation and other important information. The flight trajectory is tracked by radar and recorded.

As the ram-jet's thrust at low speeds is not sufficient to propel the aircraft, the "Gorgon" has first to be carried to sufficient altitude and at sufficient speed by a "mother" aircraft. In the present tests, a twin-engined Northrop "Black Widow" was used, having been specially modified to carry a "Gorgon" under the starboard wing, and a fuel tank beneath the

MOTHER AIRCRAFT TAKES OFF WITH A "GORGON IV" under the starboard wing. Beneath the port wing is a jettisonable fuel tank to restore the balance.

"GORGON IV" IN FREE FLIGHT, propelled by the ram-jet engine beneath the fuselage rear.



FISHING OFF THE CALIFORNIAN COAST. The "Gorgon IV," having descended by parachute, is hauled on to the deck (top) and sprayed with fresh water (centre) to allay corosion. The instrument and radio specialists then start to divest it of its valuable instrumentation (bottom). The damage due to landing and recovery is frequently very slight and can easily be repaired.

opposite wing to counteract the weight and drag. During the flight, fuel is pumped from the carrier aircraft's port wing tank into the "Gorgon," the same amount simultaneously being pumped into the auxiliary tank in order to restore the balance. The fuel is then ignited in the ram-jet by means of a spark plug, and the "Gorgon" released. From then on, it is for the ground stations to start working. The flight lasts until the fuel has been exhausted.

As soon as powered flight ceases, a parachute opens automatically and enables the missile with its valuable set of instruments to drop gently into the sea. A ship is soon on the spot to recover it. Then the work starts on evaluating the measurements which will guide the future development of ram-jet engines for powering guided missiles and high-speed aircraft.

Such sustained, controlled flights with the "Gorgons" have been proceeding already for several months at the U.S. Naval Air Missile Testing Centre, Point Mugu. Located on the South Californian coast, west of Los Angeles, this important test station includes, alongside firing ramps for guided missiles, a number of flight-measuring and radio stations installed on various islands. Apart from yielding plenty of valuable data for further evaluation of the ram-jet, the flight tests of the "Gordon IV" have also revealed that the telemetering system selected is extremely reliable—an important result for when rocket missiles would eventually have to be guided over enemy territory to their targets.

Moreover, the damage suffered by test "Gorgons" landing on the water has, thanks to the parachute recovery system, been slight. Some of the accompanying photos show, for instance, that the rear half of the ram-jet of Model No. 19 (above photo) was slightly knocked out of shape by the impact with the water, whereas No. 17 (centre and lower photos) seems to have hit the surface at a steeper angle, breaking off the nose feeler which contains the dynamic pressure gauge, antennae, etc. ; a few scars are also discernible at the tip of the starboard wing.

Resistance Wire Strain Gauges and their Application

By Walter RAMBERG, National Bureau of Standards, Washington, D.C.

(Conclusion) *

5. Applications

The applications of the wire strain gauge are far too numerous to be listed in one article. Many of the applications are described in the Proceedings of the U.S. Society for Experimental Stress Analysis. Only a few will be indicated below.

a) *Static strain measurements*

The majority of wire strain gauges are used for measuring static strain, that is, strain produced by loads which vary so slowly with time that the effect of rate of change of load with time is negligible.

The wire strain gauge is generally connected into an arm of a Wheatstone bridge (figure 5) since this provides a convenient means for measuring the small changes in resistance produced by strain in the wire. The bridge is balanced at the initial load, and the strain under load is determined from the change in resistance required to restore the bridge to balance. The condition of balance for the bridge in figure 5 is given by the familiar equation

$$\frac{R_A}{R_B} = \frac{R_C}{R_D} \qquad (6)$$

If strain is to be measured with one wire strain gauge only, this gauge may be connected into one arm at R_A. As indicated above, the effect of temperature variations may be eliminated by placing a temperature compensating gauge into arm R_B of the bridge. It is important that this temperature compensating gauge be of the same type as the stressed gauge and that it be fastened in the same manner to a piece of the same material which is exposed in a stress-free state to the same temperature changes as the stressed gauge. Temperature compensation can be obtained by attaching the compensating gauge to the structure next to the stressed gauge but at right angles to it, if the stress is uni-axial and along the gauge line of the stressed gauge; in that case it is possible to make a correction for the transverse strain under load. Temperature compensation is automatic if the bridge is used for measuring strains of opposite sign; as, for instance, at the extreme fibres of a bent plate. In this case one may connect one of the two wire strain gauges subjected to bending strain in place of the temperature compensating gauge at R_B.

Strains corresponding to changes in gauge resistance may be measured conveniently with the SR-4 Strain Indicator shown in figure 6. This indicator has a strain range of $\pm 1.5 \times 10^{-2}$. It contains a battery-operated fixed-frequency audio oscillator, a Wheatstone bridge with calibrated balancing adjustments, two arms of a second Wheatstone bridge which is completed by externally-connected strain gauges, an audio amplifier, a bridge rectifier and phase-discriminating network. When the indicator is used with strain gauges having calibration factors between 1.77 and 2.20, the gauge factor is set on a calibrated dial so that the indicator reads directly in strain. Balancing of the indicator is accomplished by adjustment of a slide wire dial calibrated in divisions of 10^{-5}. Electrical balance is indicated by a zero-centre panel meter.

Fig. 6: SR-4 strain indicator.

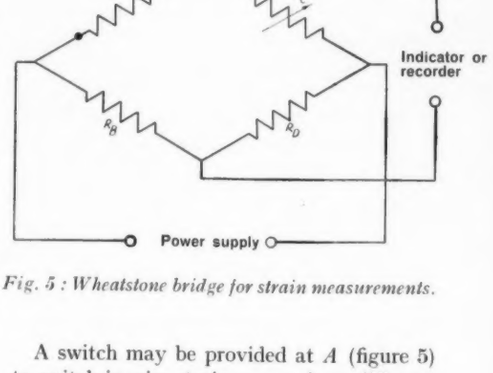


Fig. 5: Wheatstone bridge for strain measurements.

A switch may be provided at A (figure 5) to switch in wire strain gauges from different stations on the structure. It is important to use switches with clean contacts in order to minimise errors caused by changes in contact resistance. Ordinary radio gang switches with silver contact points have been successfully used for this purpose at the National Bureau of Standards.

Changes in resistance corresponding to strain at a large number of stations may be recorded with the SR-4 Scanning Recorder, shown in figure 7. This recorder has an ingenious mechanism for switching in each one of 48 Wheatstone bridges in succession, balancing the bridge and making a pen and ink record of the balance point on the chart with 48 sectors shown in the figure. A time of about 1½ minutes is required to record the output from 48 gauges.

b) *Dynamic strain measurements*

Rapidly changing strains may also be measured with the Wheatstone bridge of figure 5. However, one must replace the indicator by a recorder with a sufficient frequency range of flat response to follow the strain variations. Direct recording is seldom attempted, as the variations in bridge voltage are very small and generally require amplification in order to drive a recording system.

There exist several recorders which employ amplifiers to step up the signal from the wire strain gauge to an adequate level. Records of strain variations with an equi-

* INTERAVIA, Review of World Aviation, Vol. IV, No. 1, pp. 27-29.

valent sinusoidal frequency [1] up to 200 c.p.s. are obtained at the National Bureau of Standards with the equipment shown in figure 8. This consists of a four-channel high-frequency bridge (*A*) with controls for balancing both the reactive and the resistive components of the current. The current for the bridge is supplied with the 1,000-c.p.s. oscillator *B*. The unbalanced bridge current is then amplified to the desired level and passed through a band pass filter which passes frequencies between 800 and 1,200 c.p.s., so that higher frequency disturbances, which cause higher and lower sidebands, are eliminated from the record. The filter output is rectified and passed through one of the six galvanometers in the Heiland portable recorder *D*. Figure 9 shows some typical records of strains set up in a load dynamometer in the landing assembly of a model aeroplane subjected to a vertical landing impact. For the sake of convenience, these strains are scaled in load units. In this case a galvanometer with a natural frequency of 430 c.p.s. was used to record the strain as a function of time.

Space precludes a description of the many other combinations of bridges, amplifiers, and recorders that are commercially available in the United States for such measurements. An adequate description should include in particular the equipment developed by William Miller & Co., and by the Consolidated Engineering Corporation, both in Pasadena ; the Hathaway Instrument Company, Denver ; and the Glenn L. Martin Company, of Baltimore. Some of this equipment is described in references 9 to 13.

c) *Measurement of other mechanical quantities*

The wire strain gauge may be used to measure other mechanical quantities besides strain, provided that this other quantity produces a strain of measurable magnitude proportional to it. Some of the applications are illustrated by the sketches in figure 10. Stresses may be measured in elastic materials by using Hooke's law. For instance, we have for the stress σ_x at the surface of an elastic body in two-dimensional stress in the x and y directions

$$\sigma_x = \frac{E}{1-\nu^2}(\epsilon_x + \nu\epsilon_y) \qquad (7)$$

where

E = Young's modulus
ν = Poisson's ratio
ϵ_x = strain in x direction
ϵ_y = strain in y direction

The stress σ_x would be indicated directly for a material with a given value of ν by a strain gauge in which the resistance is changed in proportion with $\epsilon_x + \nu\epsilon_y$. Such a strain gauge was developed by Kern (reference 14) by winding a wire in a herring bone pattern, as shown in figure 10*a*.

Forces, bending moments, and torque can be measured with wire strain gauges by making the loads pass through an elastic dynamometer (figure 10, *b* to *d*). Notable among such dynamometers is the equipment for weighing aircraft developed by the Cox and Stevens Aircraft Corp. (reference 15).

Pressures may be measured with a pickup consisting of a small thin-walled tube to which the unknown pressure is internally applied (figure 10*e*, left), and which is strained circumferentially while the tube expands under pressure ; wire strain gauges should be placed along the circumference of the tube in this case. Pressure may be measured also by the extreme fibre strain produced in a circular plate with clamped edges exposed to the pressure on one side (figure 10*e*, right).

Small displacements may be measured by the bending strain set up in an elastic ring which is compressed diametrically by the unknown displacement (figure 10*f*). This is the principle of a device developed by Aleck, Goland, and Morris (reference 16).

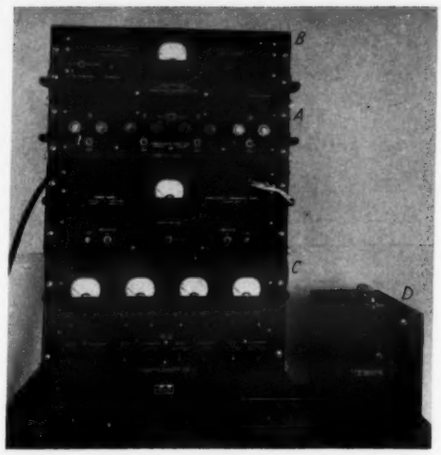


Fig. 8 : Equipment for recording output from four wire strain gauges during dynamic tests.

A Four-channel Wheatstone bridge
B Oscillator
C Amplifier
D Portable recorder

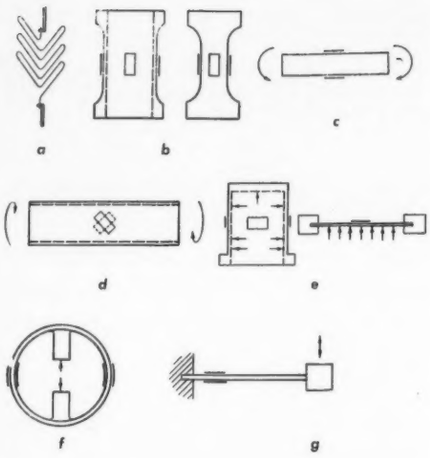


Fig. 10 : Application of wire strain gauges to the measurement of other mechanical quantities.

a Stress
b Force
c Bending moment
d Torque
e Pressure
f Displacement
g Acceleration

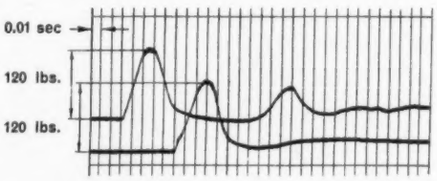
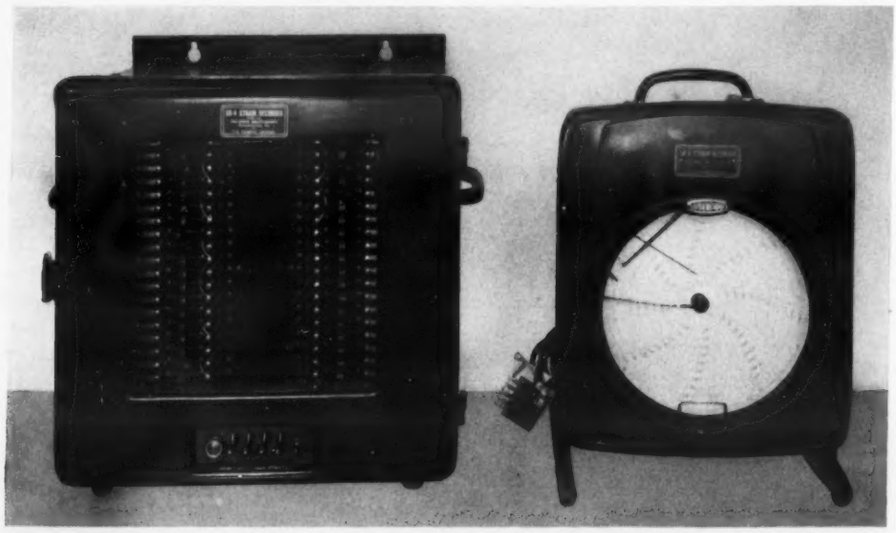


Fig. 9 : Record of loads in undercarriage of model aircraft during landing impact test.

[1] The equivalent sinusoidal frequency of the strain variations is taken as that of the highest frequency component of the Fourier series which adequately describes the variation of the strain with time.

Fig. 7 : SR-4 scanning recorder, with mechanism for switching in each one of 48 Wheatstone bridges.



Accelerations may be measured by the bending strain in a cantilever beam with a mass at the free end designed to have a natural frequency that is high compared to the equivalent sinusoidal frequency of the accelerations to be measured.

No mention is made in this paper of the pickups of a related type in which displacements, strains, accelerations, pressures, and so forth, are caused to strain an unbonded set of fine wires, thereby changing their resistance. The Statham Laboratories, Los Angeles, lead in this field.

6. Conclusions

The wire strain gauge is a convenient and economical means of measuring and recording mechanical quantities such as strain, load, pressure, displacement, and acceleration, particularly at inaccessible locations and under dynamic conditions in which the quantity to be measured varies rapidly with time.

Measurements of large strains, extending into the plastic range of metals, are possible with available gauges, although the accuracy of the measurement is generally not as good as for elastic strains, and gauges often fail. Errors caused by zero shift may become troublesome in measuring strains over long periods of time, and over shorter periods in the presence of oscillatory strain. These errors may be expected to augment with increasing temperature.

Further development of the wire strain gauge is urged in order to improve its performance with respect to zero shift and to extend its range of application to higher temperatures.

BIBLIOGRAPHY

1. CAMPBELL, William R. - *Performances Tests of Wire Strain Gauges : I. Calibration Factors in Tension.* NACA Technical Note No. 954, 1944.
2. CAMPBELL, William R. - *Performance Tests of Wire Strain Gauges : II. Calibration Factors in Compression.* NACA Technical Note No. 978, 1945.
3. CAMPBELL, William R. - *Performance Tests of Wire Strain Gauges : III. Calibration at High Tensile Strains.* NACA Technical Note No. 997, 1945.
4. CAMPBELL, William R. - *Performance Tests of Wire Strain Gauges : IV. Axial and Transverse Sensitivities.* NACA Technical Note No. 1042, 1946.
5. CAMPBELL, W. R., and MEDBERY, A. F. - *Performance Tests of Wire Strain Gauges : V. Error in Indicated Bending Strains in Thin Sheet Metal due to Thickness and Rigidity of Gauge.* NACA Technical Note No. 1318, 1947.
6. CAMPBELL, William R. - *Performance Tests of Wire Strain Gauges : VI. Effect of Temperature on Calibration Factor and Gauge Resistance.* NACA Technical Note No. 1456, 1948.
7. SWAINGER, K. H. - *Electrical Resistance Wire Strain Gauges to Measure Large Strains.* " Nature, " Vol. 159, January 11th, 1947.
8. BAUMBERGER, R., and HINES, F. - *Practical Reduction Formulas for use on Bonded Wire Strain Gauges in Two-Dimensional Stress Fields.* S.E.S.A. (Society for Experimental Stress Analysis) Proceedings, Vol. 2, No. 1, pp. 113-127, May, 1944.
9. RENO, H. - *Instruments for Aircraft Strain Analysis.* S.E.S.A. Proceedings, Vol. 2, No. 2, pp. 106-117, 1944.
10. HATHAWAY, C. M. - *New Portable Stress Analysis Equipment.* S.E.S.A. Proceedings Vol. 4, No. 1, pp. 56-63, 1946.
11. ANON. - *Dynamics Measurement Equipment.* Bulletin of The Glenn L. Martin Co., Baltimore, Md.
12. ANON. - *Linear and Carrier Type Amplifying Equipment for Measuring Acceleration, Strain, and Velocity.* Bulletin of Consolidated Engineering Corp., Pasadena 4, Calif.
13. ANON. - *Model BL-211 Single Channel Magnetic Oscillograph and Amplifier.* Bulletin of Brush Development Co., Cleveland. Ohio.
14. KERN, R. E. - *The Stress Gauge.* S.E.S.A. Proceedings, Vol. 4, No. 1, pp. 124-129, 1946.
15. THURSTON, A. L., and CUSHMAN, R. W. - *Precision Determination of Weight by means of Bonded Strain Gauges.*
16. ALECK, J., GOLAND, M., and MORRIS, L. D. - *The Load Distribution in Riveted and Spot-Welded Joints.* S.E.S.A. Proceedings, Vol. 2, No. 2, pp. 28-38, October, 1944.

Structure Weight

By Norman S. CURREY, Grad.R.Ae.S., Hatfield, Herts.

What exactly do we mean by " Structure Weight " ? It can be defined as the weight of the actual structure of the aircraft with no power units, fuel or oil systems, pressurising equipment, furniture, fuel, oil, crew and equipment, passengers, baggage, or food and drink. In other words, it is the weight of the spars, ribs, formers, longerons, stringers, floors, skins, etc. It is therefore apparent that the stressman can either make or mar a design. A good stress office can, by careful and accurate analysis used in conjunction with experience, increase the payload of an aircraft by a very appreciable amount. Take the Airspeed " Ambassador " for instance, for which the structure weight is 18,280 lbs. out of the gross weight of 52,000 lbs. The 40 passengers have a total weight of 6,800 lbs. If only 260 lbs. were saved on the structure weight, *i.e.* a reduction of 1.4 per cent., the increase in payload would be 2.5 per cent. This 260 lbs. is made up as follows : one passenger 170 lbs., his seat 40 lbs. and his luggage 50 lbs.

The value of this can be realised when one considers the earning capacity of one extra passenger over the life of the aircraft. The maintenance, operating, and depreciatory costs of the aircraft would still be the same ; so assuming this aircraft were operating for 2,500 hours per annum, it should be able to make about two hundred 2,000-mile trips. If a passenger paid, say, £40 for this trip, we would have a gain of £8,000 per annum per aircraft with one extra passenger. The aircraft could be expected to have an operating life of at least five years, and assuming twenty aircraft were operating, there would be an overall gain of £800,000 over five years. And all because 260 lbs. was saved in the structure weight ! This could be achieved merely by meticulous

design of every small bracket, attachment, and rivet group—chopping pieces off here and there.

In the case of large jet-propelled airliners of the 100,000-lb. category, this structure weight is even more vital ; we still carry only about 6,000 lbs. weight in passengers, the rest of the weight being made up by an enormous amount of fuel and increased structure weight to cater for the larger loads imposed by high-speed flight. With an aircraft of this type on, say, the London-New York run, one extra passenger per journey would mean a gain of £32,000 per annum per aircraft. With ten aircraft operating for five years we would have an overall gain of £1,600,000 or £6,150 per pound of weight saved. Never has a pound of non-precious metal been worth so much as it is now !

The aim of this article is to analyse the structure weights of various aircraft of different sizes over the past few years, considering their individual construction and so trying to find the reason for their various structure weights.

Aircraft	Year of prototype specification	All-up weight (lbs.)	Wing loading (lbs./sq.ft.)	Ultimate Flight Factor	Max. design diving speed (m.p.h. I.A.S.)	Approx. fuselage surface area (sq. ft.)	Root t/c ratio (%)	Structure Weights						
								Component Weights (% A.U.W.)						
								Wings	Fuselage	Undercarriage	Tail unit	Nacelle structure and fairing	Controls	Total structure (% A.U.W.)
"Wellington"	1932	36,500	43	4.2	320	1,350	17	10.1	9.0	3.4	1.6	3.1	0.5	27.7
"Whitley 5"	1934	33,500	27	6.0	250	1,230	20	12.3	7.1	3.8	2.1	1.8	0.6	27.7
"Hurricane 2C"	1934	7,800	29	10.7	450	250	19	16.2	7.2	5.5	2.1	0	0.9	31.9
"Halifax 3"	1936	63,000	50	4.5	320	1,480	21	11.7	5.8	4.7	1.5	1.7	0.5	25.7
"Beaufighter 10"	1939	25,000	50	8.5	400	500	19	9.8	6.6	4.3	1.9	2.1	0.6	25.2
"Lightning"	—	15,000	46	11.2	571	350	16	12.3	9.1	5.9	2.8	3.0	1.5	34.6
"Mosquito 2F"	1940	18,550	41	8.0	450	450	13	14.5	4.2	5.7	2.1	1.5	0.5	28.5
"Mosquito B4"	1940	20,800	46	6.5	450	450	13	13.0	4.3	4.7	1.9	1.3	0.5	25.7
"Tempest 5"	1941	11,720	37	14.0	550	275	15	15.6	6.6	6.3	2.0	0	0.8	31.3
"Vampire"	1941	10,298	39	10.0	550	220	14	12.1	6.3	4.1	1.4	0	1.1	25.0
"Lancaster 3"	1941	50,000	50	4.35	400	1,310	18	11.0	6.4	4.5	1.7	2.6	0.4	27.0
"Superfortress"	—	105,000	60	4.0	—	2,400	14	13.9	6.9	6.7	1.4	2.1	0.5	31.4
"Spiteful 14"	1943	9,220	44	12.0	525	310	13	14.0	4.1	4.3	1.5	0	0.9	24.8

Military Aircraft

Military aircraft, the subject of the first part of this analysis, are a somewhat different proposition from the instances previously considered. But here again the saving of structure weight is just as vital. It allows for heavier armament or bomb loads, or in some cases a lower wing loading, with consequent greater speed variation, and greater versatility.

At first sight it seems difficult to make a general statement on the trend of structure weights in military aircraft. The percentage of gross weight is still about the same today as it was ten years ago. Since materials of far higher strength-to-weight ratios are now being used, and structural design has reached a higher level of perfection, it seems natural to assume that structure weight percentages would have gone down. The reason for their not having done so can be attributed mainly to :—

a) increased speeds, inducing higher loads ;

b) increased aerodynamic efficiency at the expense of structure weight ;

c) increased torsional stiffness.

The increased speeds not only increase the wing bending moments, but considerably worsen the gust effects. Increased aerodynamic efficiency in the form of thinner wings with smoother, non-wrinkling surfaces, necessitates a much stronger wing than would normally suffice ; for instance, the higher the span-to-depth ratio of the wing spar, the smaller its strength-to-weight ratio. Finally, torsional stiffness requirements may be the design criterion for some present-day wings, and this varies as the Mach number and the square of the velocity. Hence, as the speed increases, the structure weight becomes larger and larger.

Undercarriages are gradually becoming stronger to withstand the loads induced by greater landing speeds, but have taken advantage of the higher-strength alloys and improved shock absorption to prevent any weight increase.

Some formulae have been derived to estimate the approximate structure weights of the fuselage of projected aircraft. The following formula, in fact slightly pessimistic —a good fault in the early stages—serves to show what factors influence this structure weight :—

$$\frac{W_F}{S_F} = 1.0 + 0.05\left(\frac{W}{S_F}\right)$$

where W_F = fuselage weight (lbs.),

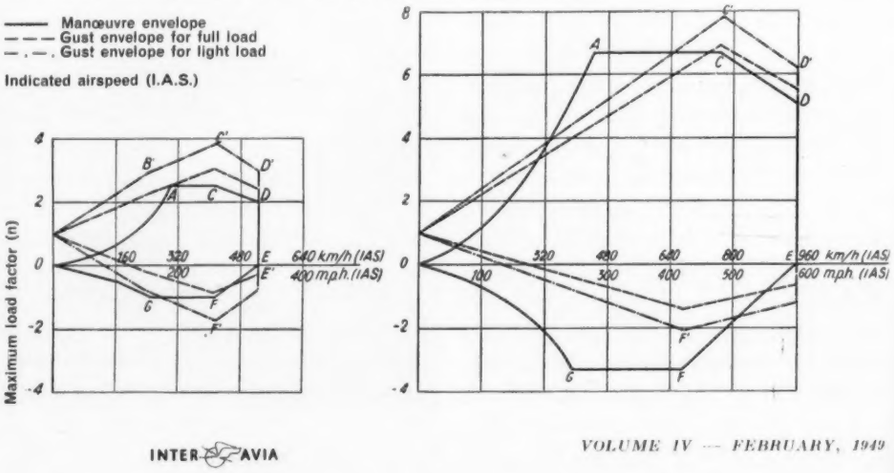
W = max. gross weight (lbs.),

S_F = fuselage surface area in sq.ft. (not including engine bay on single-engined aircraft).

The above table shows how the structure weight has varied over the last few years on a typical range of military aircraft. Some of the figures may now be superseded, but are the latest available.

What conclusions can be drawn from these ? They serve to illustrate the findings of the previous paragraphs. Consider, as a

Figs. 1 and 2 : Variation of the maximum load factor (n) *for a transport aircraft and for a purely hypothetical high-speed aircraft with and without gust effect. The Ultimate Flight Factor* (N) *of the undercarriage should be at least 50 per cent. greater than* n.



case in point, the " Hurricane 2C " and the " Tempest 5 "—both from the same stable. The specification of the " Tempest " was issued seven years after that of the " Hurricane, " and the design diving speed was 550 m.p.h. instead of 450 m.p.h. The wing loading increased from 29 lbs./sq.ft. in the case of the " Hurricane, " to 37 lbs./sq.ft., so necessitating a stronger wing. This factor, and the greater loads by greater speeds, offset to a large extent the advantages which would normally have been gained through the use of higher-grade materials and better structural design. The " Hurricane " wing was of a very heavy type of construction ; it consisted of four metal spars, a multitude of metal ribs, warren girders, and a metal skin. The " Tempest " wing, on the other hand, had a far greater strength-to-weight ratio, with its two main metal spars, stringers, and metal skin. There was also greater inertia relief in this latter aircraft from various items, such as fuel tanks and magazines housed in the wing. Thus, we see the " Tempest " with a wing of 15.6 per cent. gross weight, as opposed to the " Hurricane " with a wing of 16.2 per cent. gross weight—a very high figure for this type of aircraft.

The " Vampire " is an example of sheer refinement of design, mainly due to the advantages of the jet installation. Although it has a design maximum diving speed of 550 m.p.h. and an Ultimate Flight Factor of 10 on its combat weight of 10,298 lbs., the structure weight is only about 25 per cent. of the gross weight. The " Vampire " owes this very low figure mainly to the simplicity of its design, and its very short undercarriage legs. The wing is one of its best features from the weight point of view, this being due, probably, to the large inertia relief from the fuel carried in the wings and drop-tanks, together with the simplicity and efficiency of the structural design.

The " Mosquito's " fuselage weight is another striking feature, being only 4.2 per cent. of the gross weight in the case of the Mark 2F. This is no doubt due to the high structural efficiency of using the ply, balsa, ply sandwich skin, which needs very few longerons or bulkheads to meet the strength requirements. What is more, most of the weight is concentrated round the centre of gravity, thereby reducing the fuselage bending moments.

Civil Aircraft

Civil aircraft present a very different problem to those previously considered. Their structure weights are determined, on the one hand, by passenger capacity and comfort, on the other by gust effects, type of fuel tanks, type of wing construction, fuselage shape, and so forth.

The wings are now tending to be of box-beam construction, as, unlike military aircraft, recesses are not required for armament or separate fuel tanks. By using box beams it is possible to develop stresses approaching the proof strength of the plating used—a great advantage when compared with other types of construction where, although the materials used in tension can be made to develop their full ultimate strength, materials in compression tend to fail by buckling of plating, column failure of stringers and torsional instability. As sizes and speeds of aircraft increase, the benefit of the " stressed skin " wing becomes more obvious. Thick skins are not only advantageous from the buckling point of view, but facilitate countersunk riveting and, hence, make for very smooth, aerodynamically-efficient wings.

An appreciable saving in weight can be realised by using integral fuel tanks ; for example, on the Saunders-Roe SR.45 long-range flying-boat, 5,000 lbs. was estimated to have been saved by using integral tanks. This is another argument in favour of using box-beam construction.

Again, as in the case of military aircraft, the use of new, higher-strength alloys greatly increases the strength-to-weight ratio.

These factors tend to reduce the structure weight of the wing, but are offset by the new strength requirements. At first sight one is apt to wonder why no great improvement in wing weight has been made in recent years, particularly in view of the higher-grade materials and more detailed stressing. The answer lies mainly in gust effects. Before the War the normal flight manœuvre envelope was used as the basis for load factors. Now, however, the gust envelope is superimposed on this, so greatly increasing the factors. Two typical charts, showing the variation of the maximum load factor with and without gust effect, are given : Fig. 1 for an ordinary transport aircraft, and Fig. 2 for a purely hypothetical high-speed aircraft with high maximum load factor and high maximum diving speed. They represent

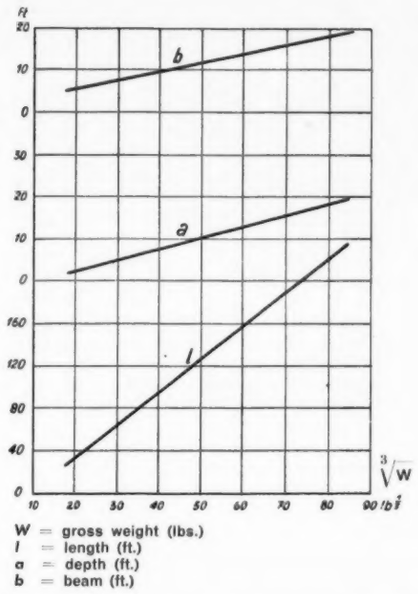


Fig. 3 : The fuselage dimensions of civil aircraft are in general directly proportional to the cube root of the gross weight.

a full series of manœuvres : the aircraft begin diving at maximum diving speed for points E to D, and then pull out, gradually reducing speed and attaining maximum load factor at C. Subsequently, at point A, the high-speed stall is reached. As speeds and operating altitudes increase, this effect becomes worse and worse, until, as in the case of some present-day projects, we find it as the design criterion for the whole structure. Gust alleviating devices will probably be fitted in the future when their inherent complications have been overcome, and these should save about 5 per cent. on the all-up weight. The various types under research today include the " aileron method " (Bristol " Brabazon 1B "), where the gust-warning device in the nose (see cover-page photo of *Interavia*, Vol. III, No. 10) quickly changes the angle of both ailerons on hitting a gust, thereby reducing the wing load by creating a load in the opposite direction to the gust, and also an opposite torque. (It is useful to keep in mind that the distance from the tip of the gust-warning device to the leading edge of the " Brabazon's " wing is about 85 feet.)

Other factors tending to increase the wing weight are the same as for the military aircraft : increased speeds, increased aerodynamic efficiency, and the increased torsional stiffness requirements.

Fuselage structure weight is influenced by the all-up weight of the aircraft, dimensions

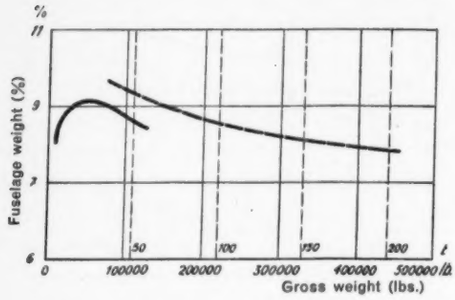


Fig. 4: Percentage weight of fuselages with size. As the size increases, the percentage weight of the fuselage decreases.

— — — Cylindrical pressurised fuselages
——— Non-pressurised fuselages

of the aircraft, surface area, fineness ratio, pressurisation, loading density, and gust effects.

By analysing the curves in Fig. 3,* plotted from figures for a range of aircraft types, we see that the dimensions are in general directly proportional to the cube root of the gross weight. Fig. 4 * shows the percentage weights of fuselages with size, and this indicates that, as the size increases, the percentage weight of the fuselage decreases.

Wetted area reduction is the most effective way of reducing fuselage weight. As an indication of this effect we find that the wetted area is directly proportional to the cube root of the gross weight squared. Loading density influences the wetted area, its influence being apparent when we compare two similar aircraft of approximately the same range and weight, one being a freighter and the other a passenger carrier. As an example, let us compare the Avro " Lancastrian " and the Avro " York " for freight- and passenger-carrying respectively. The details are as follows :—

	" Lancastrian "	" York "
Wing area	1,296 sq. ft.	1,296 sq. ft.
Fuselage wetted area	1,557 sq. ft.	2,157 sq. ft.
Max. stressing speed	400 m.p.h.	320 m.p.h.
Ultimate flight factor	4.07	5.07
Take-off weight	65,000 lbs.	68,000 lbs.
Range	2,820 miles	2,600 miles

It can be seen that these two aircraft are very much alike in all respects, except for the wetted area; the " York, " being the passenger carrier, has 39 per cent. more area.

Passenger capacity and comfort, and fuselage fineness ratio are all interconnected. Passenger capacity, combined with floor space and volume per passenger are dependent (*a*) on length of journey, and (*b*) on comfort required. The latter is a very vague requirement and much weight could be saved if some research was done to estimate the optimum comfort necessary for various durations of flight. At present, airliners are tending to be far more luxuriously equipped than need be. Once the cabin volume has been decided upon, it is then only a matter of finding the most economical fuselage geometry, the general effect of a lower fineness ratio being to reduce the wetted area, and so reduce the fuselage weight.

By pressurising a fuselage an increase of approximately 8 per cent. can be expected on the weight of the non-pressurised version, quite a large proportion of this being in the structure itself (all joints must be sealed, and additional fittings must be added to seal windows, doors, rods passing through bulkheads, etc.). As the sizes increase, a reduction may be expected on the above figure of 8 per cent.

Having dealt with the factors influencing the structure weight of civil aircraft, a selection of structure weight percentages of contemporary civil aircraft is given.

Aircraft	Structure weight (lbs.)	Structure weight in percentage of all-up weight	All-up weight (lbs.)
" Merganser "	2,640	36.1	7,300
" Dove "	2,390	28.1	8,500
" Concordia "	4,450	35.6	12,500
" Dakota III "	8,830	31.5	28,050
" Viking "	10,480	31.8	33,000
Bristol 170	13,733	37.6	36,500
" Ambassador "	18,280	35.0	52,130
" Hastings "	19,505	26.0	75,000
" Tudor 1 "	22,290	29.3	76,000
" Constellation "	27,217	28.5	105,240
" Brabazon 1B "	83,900	27.9	300,800

Except for the Bristol 170 " Freighter " and Airspeed " Ambassador," these figures bear out the curve showing decrease of structure weight percentage with increase of gross weight. The structure weight of the " Dove " calls for some comment. Its very low structure weight percentage may be attributed to the excellence of its design, with great use being made of Redux-bonded stringers and very simple construction.

Conclusions

It is worth taking a great deal of trouble to ascertain the most economical fuselage shape with minimum fineness ratio and surface area, the latter being perhaps the most important criterion for fuselage weight.

Box-beam wing construction should be used wherever possible, as the skins can be used almost up to their proof and ultimate strengths. To achieve this, great care should be taken to minimise the number of cut-outs. Integral fuel tanks, with their weight reduction properties, may then be used to advantage.

Cemented joints and stringers greatly improve the strength-to-weight ratio, and incidently lead to a far smoother surface with greater aerodynamic efficiency.

By using magnesium alloy for lightly loaded parts, more weight is saved, and little trouble is experienced from instability, owing to its bulk.

Great care should be taken in designing and stressing each individual component, no matter how small, as a few pounds saved here and there is worth a great deal over the operating life of the aircraft.

Optimum passenger comfort calls for some research, too. In estimating this, we might well save a great deal of weight by reducing the passenger cabin volume and reducing the fineness ratio, and thus reducing the structure weight.

Some further research into gusts is urgently needed to ascertain the actual gust gradient and speeds at various heights. At present we assume that the gust gradient distance is 100 feet, irrespective of gust velocity, and that the gust speed increases up to altitudes of 25,000 feet, after which it remains constant. From recent American tests it seems that this is optimistic. Gust alleviating devices should be used as soon as possible.

* Derived from curves in *R. Ae. S. Journal* for November, 1947.

Electric Spot-Welding of Pressed Sheet Parts

in the Serial Manufacture of the SECAN "Courlis" Personal Aircraft

By G. BRUNER, B.Sc., Paris

The degree of skill attained in aircraft manufacturing during the war allowed for the application of time-saving mass production methods.

The line-assembly system, similar to that utilised in the manufacture of automobiles, was adopted universally. But the actual principles of manufacture were modified only very little ; the classic structures of riveted duralumin were retained, notwithstanding all the shortcomings revealed by this system : high costs, complicated construction, thin sheeting necessitating multiple stiffenings, and so forth. As the factories had to produce the largest possible number of aircraft in the shortest possible time, the manufacturing-cost aspect was considered to be of secondary importance.

Since the return of peace and the conversion of the aeronautical industry to the needs of commercial and private aviation, it is unfortunate that pre-war methods are still being continued for manufacturing civil aircraft ; and since the series are necessarily small, this results in intolerable sales prices. A number of the modern four-seater personal aircraft cost seven to ten times as much as a good mass-produced automobile, and it is almost impossible to find private customers for them unless the State offers some sort of subsidy to either the manufacturer or the customer. It is therefore for the aircraft industry to study and perfect new manufacturing methods which are much less expensive than those used at present.

The first aircraft destined for private flying purposes were built of wood, the exterior surfaces having a fabric skin. This was a simple procedure which was very suitable for manufacture in small series. But as soon as the series became larger, the costs did not sink nearly as sharply as they do in the manufacture of metal aircraft, and the cost price could not be dropped below a certain limit. Beyond a certain number of aircraft of the same series, no further economy in price can be achieved in connection with the cutting and glueing of the wood. Besides this, a wooden aircraft is generally heavier than a corresponding light-alloy type, and its fabric-covered surfaces make it extremely sensitive to weather influences. There was, therefore, no alternative but to return to metal aircraft.

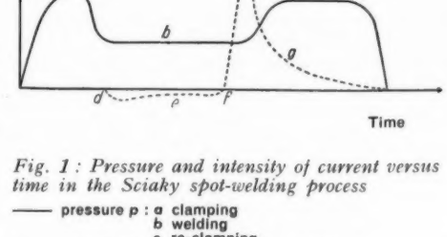


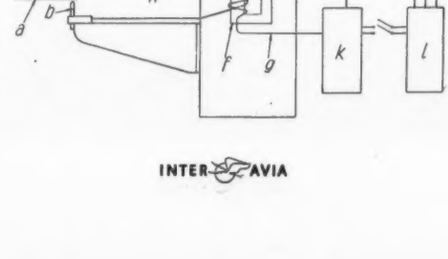
Fig. 1 : Pressure and intensity of current versus time in the Sciaky spot-welding process

—— pressure *p* : *a* clamping
b welding
c re-clamping
------- intensity *i* of current through electrodes
d switched on
e charge
f switched off
g discharge

Already before the war attempts were made to replace the expensive manufacture from light alloy sheet assembled by thousands of difficulty accessible rivets, with more economic methods. In an endeavour to reduce the price of manufacture, engineers wished to find another procedure which, whilst retaining the thin sheeting as principal element of the structure, enabled the expensive riveting to be suppressed : the only choice was therefore to *weld* the joints.

All attempts at gas welding high-strength light alloys (duralumin) have so far been unsuccessful. At the welding point, the duralumin, under the influence of the high temperature of the flame, is transformed again into pure aluminium, which is not at all strong and makes the joint very fragile and sensitive to shocks.

Fig. 2 : Function of the Sciaky spot-welding machine. The object to be welded a *is introduced between two electrodes, of which the lower one* b *is fixed and the upper one* c *actuated by the piston* d *and a pneumatic cylinder* e. *The electrical circuit is made up of an induction coil* f *of a primary D.C. circuit* g, *and a high-intensity secondary circuit* h. *The primary circuit passes through a maximum-intensity relay* k *for dosing out the exact quantity of welding energy required. If no D.C. current is available a mercury-vapour rectifier* l *is installed.*



Another attempt, which was much more successful, consisted in joining two sheets by means of a row of spot-welds, obtained by sending an electric current over a very short period through two electrodes clamping the sheets together. The spot-welding machines of Sciaky and others were conceived.

Electric spot-welding results in a very appreciable saving of manufacturing time. In the first place, the long and expensive procedure of locating and drilling holes, indispensable in riveted or bolted structures, is avoided. In the second place, the actual welding, especially with the clamp which requires no introduction of another element (rivet or bolt), can be carried out at a much higher speed.

The spot-welded joint between two sheets of steel is of approximately the same strength as a conventional rivet. There is no disadvantage incurred if the pressure between the electrodes is maintained constant during the entire period — which is extremely short anyhow—of the electric current's passage.

Where light-alloy sheets have to be spot-welded, use must be made of a procedure in which the pressure is diminished and later increased, the aim being to prevent the mechanical qualities of the welded alloys from suffering under the effect of the increased temperature. This procedure, utilised by the Société Sciaky, consists in varying the electrodes' clamping pressure during the welding cycle in the following manner (Figs. 1 to 3) :

1) The parts to be welded are strongly clamped between the electrodes in order to improve the contact in the area through which the welding current will pass ; this we shall call the *clamping period*.

2) This pressure is diminished and maintained constant during the *welding period* (discharge of electric current).

3) During the electric discharge period the pressure is augmented again, to a value exceeding the elastic limit of the metal, the aim being to give the metal a cold-hardening which compensates any impairment of its

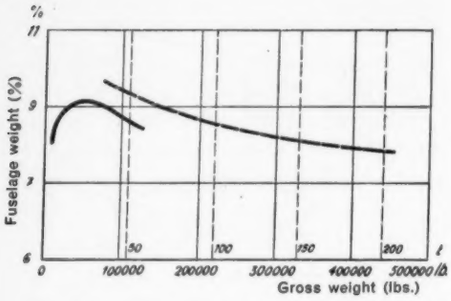


Fig. 4 : Percentage weight of fuselages with size. As the size increases, the percentage weight of the fuselage decreases.

— — — Cylindrical pressurised fuselages
—— Non-pressurised fuselages

of the aircraft, surface area, fineness ratio, pressurisation, loading density, and gust effects.

By analysing the curves in Fig. 3,* plotted from figures for a range of aircraft types, we see that the dimensions are in general directly proportional to the cube root of the gross weight. Fig. 4 * shows the percentage weights of fuselages with size, and this indicates that, as the size increases, the percentage weight of the fuselage decreases.

Wetted area reduction is the most effective way of reducing fuselage weight. As an indication of this effect we find that the wetted area is directly proportional to the cube root of the gross weight squared. Loading density influences the wetted area, its influence being apparent when we compare two similar aircraft of approximately the same range and weight, one being a freighter and the other a passenger carrier. As an example, let us compare the Avro " Lancastrian " and the Avro " York " for freight- and passenger-carrying respectively. The details are as follows :—

	" Lancastrian "	" York "
Wing area	1,296 sq. ft.	1,296 sq. ft.
Fuselage wetted area	1,557 sq. ft.	2,157 sq. ft.
Max. stressing speed	400 m.p.h.	320 m.p.h.
Ultimate flight factor	4.07	5.07
Take-off weight	65,000 lbs.	68,000 lbs.
Range	2,820 miles	2,600 miles

It can be seen that these two aircraft are very much alike in all respects, except for the wetted area ; the " York, " being the passenger carrier, has 39 per cent. more area.

Passenger capacity and comfort, and fuselage fineness ratio are all interconnected. Passenger capacity, combined with floor space and volume per passenger are dependent (*a*) on length of journey, and (*b*) on comfort required. The latter is a very vague requirement and much weight could be saved if some research was done to estimate the optimum comfort necessary for various durations of flight. At present, airliners are tending to be far more luxuriously equipped than need be. Once the cabin volume has been decided upon, it is then only a matter of finding the most economical fuselage geometry, the general effect of a lower fineness ratio being to reduce the wetted area, and so reduce the fuselage weight.

By pressurising a fuselage an increase of approximately 8 per cent. can be expected on the weight of the non-pressurised version, quite a large proportion of this being in the structure itself (all joints must be sealed, and additional fittings must be added to seal windows, doors, rods passing through bulkheads, etc.). As the sizes increase, a reduction may be expected on the above figure of 8 per cent.

Having dealt with the factors influencing the structure weight of civil aircraft, a selection of structure weight percentages of contemporary civil aircraft is given.

Aircraft	Structure weight (lbs.)	Structure weight in percentage of all-up weight	All-up weight (lbs.)
" Merganser "	2,640	36.1	7,300
" Dove "	2,390	28.1	8,500
" Concordia "	4,450	35.6	12,500
" Dakota III "	8,830	31.5	28,050
" Viking "	10,480	31.8	33,000
Bristol 170	13,733	37.6	36,500
" Ambassador "	18,280	35.0	52,130
" Hastings "	19,505	26.0	75,000
" Tudor 1 "	22,290	29.3	76,000
" Constellation "	27,217	28.5	105,240
" Brabazon 1B "	83,900	27.9	300,800

Except for the Bristol 170 " Freighter " and Airspeed " Ambassador," these figures bear out the curve showing decrease of structure weight percentage with increase of gross weight. The structure weight of the " Dove " calls for some comment. Its very low structure weight percentage may be attributed to the excellence of its design, with great use being made of Redux-bonded stringers and very simple construction.

Conclusions

It is worth taking a great deal of trouble to ascertain the most economical fuselage shape with minimum fineness ratio and surface area, the latter being perhaps the most important criterion for fuselage weight.

Box-beam wing construction should be used wherever possible, as the skins can be used almost up to their proof and ultimate strengths. To achieve this, great care should be taken to minimise the number of cut-outs. Integral fuel tanks, with their weight reduction properties, may then be used to advantage.

Cemented joints and stringers greatly improve the strength-to-weight ratio, and incidently lead to a far smoother surface with greater aerodynamic efficiency.

By using magnesium alloy for lightly loaded parts, more weight is saved, and little trouble is experienced from instability, owing to its bulk.

Great care should be taken in designing and stressing each individual component, no matter how small, as a few pounds saved here and there is worth a great deal over the operating life of the aircraft.

Optimum passenger comfort calls for some research, too. In estimating this, we might well save a great deal of weight by reducing the passenger cabin volume and reducing the fineness ratio, and thus reducing the structure weight.

Some further research into gusts is urgently needed to ascertain the actual gust gradient and speeds at various heights. At present we assume that the gust gradient distance is 100 feet, irrespective of gust velocity, and that the gust speed increases up to altitudes of 25,000 feet, after which it remains constant. From recent American tests it seems that this is optimistic. Gust alleviating devices should be used as soon as possible.

* Derived from curves in *R. Ae. S. Journal* for November, 1947.

Electric Spot-Welding of Pressed Sheet Parts

in the Serial Manufacture of the SECAN "Courlis" Personal Aircraft

By G. Bruner, B.Sc., Paris

The degree of skill attained in aircraft manufacturing during the war allowed for the application of time-saving mass production methods.

The line-assembly system, similar to that utilised in the manufacture of automobiles, was adopted universally. But the actual principles of manufacture were modified only very little ; the classic structures of riveted duralumin were retained, notwithstanding all the shortcomings revealed by this system : high costs, complicated construction, thin sheeting necessitating multiple stiffenings, and so forth. As the factories had to produce the largest possible number of aircraft in the shortest possible time, the manufacturing-cost aspect was considered to be of secondary importance.

Since the return of peace and the conversion of the aeronautical industry to the needs of commercial and private aviation, it is unfortunate that pre-war methods are still being continued for manufacturing civil aircraft ; and since the series are necessarily small, this results in intolerable sales prices. A number of the modern four-seater personal aircraft cost seven to ten times as much as a good mass-produced automobile, and it is almost impossible to find private customers for them unless the State offers some sort of subsidy to either the manufacturer or the customer. It is therefore for the aircraft industry to study and perfect new manufacturing methods which are much less expensive than those used at present.

The first aircraft destined for private flying purposes were built of wood, the exterior surfaces having a fabric skin. This was a simple procedure which was very suitable for manufacture in small series. But as soon as the series became larger, the costs did not sink nearly as sharply as they do in the manufacture of metal aircraft, and the cost price could not be dropped below a certain limit. Beyond a certain number of aircraft of the same series, no further economy in price can be achieved in connection with the cutting and glueing of the wood. Besides this, a wooden aircraft is generally heavier than a corresponding light-alloy type, and its fabric-covered surfaces make it extremely sensitive to weather influences. There was, therefore, no alternative but to return to metal aircraft.

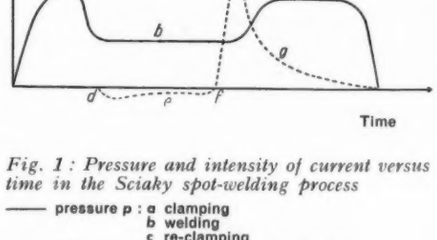


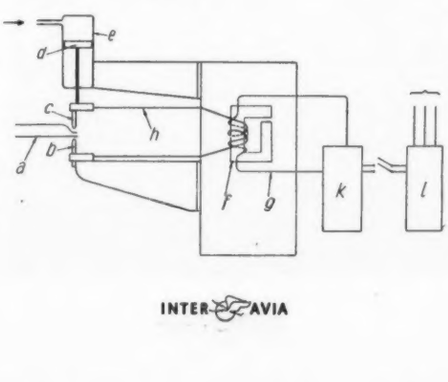
Fig. 1 : Pressure and intensity of current versus time in the Sciaky spot-welding process

—— pressure p : a clamping
b welding
c re-clamping
------- intensity i of current through electrodes
d switched on
e charge
f switched off
g discharge

Already before the war attempts were made to replace the expensive manufacture from light alloy sheet assembled by thousands of difficulty accessible rivets, with more economic methods. In an endeavour to reduce the price of manufacture, engineers wished to find another procedure which, whilst retaining the thin sheeting as principal element of the structure, enabled the expensive riveting to be suppressed : the only choice was therefore to *weld* the joints.

All attempts at gas welding high-strength light alloys (duralumin) have so far been unsuccessful. At the welding point, the duralumin, under the influence of the high temperature of the flame, is transformed again into pure aluminium, which is not at all strong and makes the joint very fragile and sensitive to shocks.

Fig. 2 : Function of the Sciaky spot-welding machine. The object to be welded a *is introduced between two electrodes, of which the lower one* b *is fixed and the upper one* c *actuated by the piston* d *and a pneumatic cylinder* e. *The electrical circuit is made up of an induction coil* f *of a primary D.C. circuit* g, *and a high-intensity secondary circuit* h. *The primary circuit passes through a maximum-intensity relay* k *for dosing out the exact quantity of welding energy required. If no D.C. current is available a mercury-vapour rectifier* l *is installed.*



Another attempt, which was much more successful, consisted in joining two sheets by means of a row of spot-welds, obtained by sending an electric current over a very short period through two electrodes clamping the sheets together. The spot-welding machines of Sciaky and others were conceived.

Electric spot-welding results in a very appreciable saving of manufacturing time. In the first place, the long and expensive procedure of locating and drilling holes, indispensable in riveted or bolted structures, is avoided. In the second place, the actual welding, especially with the clamp which requires no introduction of another element (rivet or bolt), can be carried out at a much higher speed.

The spot-welded joint between two sheets of steel is of approximately the same strength as a conventional rivet. There is no disadvantage incurred if the pressure between the electrodes is maintained constant during the entire period — which is extremely short anyhow—of the electric current's passage.

Where light-alloy sheets have to be spot-welded, use must be made of a procedure in which the pressure is diminished and later increased, the aim being to prevent the mechanical qualities of the welded alloys from suffering under the effect of the increased temperature. This procedure, utilised by the Société Sciaky, consists in varying the electrodes' clamping pressure during the welding cycle in the following manner (Figs. 1 to 3) :

1) The parts to be welded are strongly clamped between the electrodes in order to improve the contact in the area through which the welding current will pass ; this we shall call the *clamping period*.

2) This pressure is diminished and maintained constant during the *welding period* (discharge of electric current).

3) During the electric discharge period the pressure is augmented again, to a value exceeding the elastic limit of the metal, the aim being to give the metal a cold-hardening which compensates any impairment of its

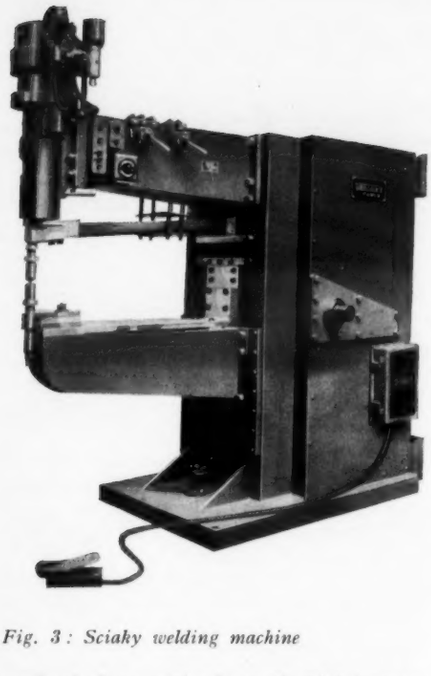


Fig. 3 : Sciaky welding machine

mechanical properties due to the high temperature.

The SUC. 10 "Courlis" four-seater personal aircraft, built by the SECAN aircraft manufacturing concern, is a high-wing monoplane with fixed nose-wheel undercarriage, pusher airscrew, and two tail booms which extend from the wing and carry the tail assembly.

The idea of the designer, Mr. Vinsonneau, was to build the aircraft around the coachwork of an ordinary automobile. Consequently, the fuselage is not an integral part of the actual airframe, the latter being built up by the wing, the tail booms and tail assembly, all fixed on the roof of the cabin. In order to facilitate manufacture, each main assembly unit of the aircraft is in turn composed of several sub-assemblies.

1. *Cabin Fuselage*

How automobile manufacturing methods can be applied to aircraft construction is distinctly discernible from the conception of the " Courlis " fuselage. The fuselage walls are made up of pressed steel sheet panels of thin gauge (0.4 mm.), spot welded to one another. The same construction method is featured in the motor-bus coachwork made by the *Chausson* concern, of which SECAN is a subsidiary.

Compared with light alloys, steel has distinct advantages where the manufacture of fuselage coques is concerned. It can be electrically welded much more easily and surely. Steel sheeting can be scoured once and for all by the supplier and, should the need arise, one can always revert to gas welding, whereas light alloy sheet has to be thoroughly scoured immediately before being welded.

Deep-drawing sheet steel is chiefly used in the manufacture of the " Courlis " tourer. Parts subjected to higher stresses, such as engine mounts, certain spar caps, the fire wall, etc., are manufactured from ordinary mild steels. A chrome-molybdenum steel which can be gas welded is used for the undercarriage legs, angle sections for reinforcing girders beneath the cabin, and certain important fittings.

The thin sheet can only be utilised provided it can be stiffened sufficiently. However, any system involving applied stringers complicates the manufacture. SECAN engineers therefore conceived the idea of reinforcing the sheet metal by cementing it on to a layer of *sponge ebonite*.

A simple comparison of weights proves that this structure is no heavier than a duralumin sheet with applied stringers :

Weight of steel sheet of 0.4 mm. thickness	3.14 kg/sq.m.
Weight of sponge ebonite plate of 10 mm. thickness	1.10 kg/sq.m.
Total weight	4.24 kg/sq.m.
Weight of duralumin sheet of 1.0 mm. thickness	2.80 kg/sq.m.
Weight of stringers (on the average 50% of sheet weight)	1.40 kg/sq.m.
Total weight	4.20 kg/sq.m.

Fig. 4 : SUC. 10 " Courlis " personal aircraft built by SECAN. Power furnished by a Mathis G.8 of 190 H.P.

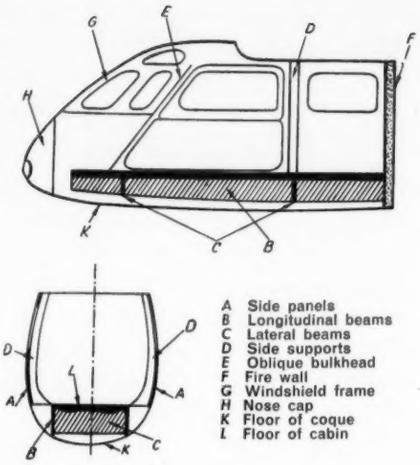


Fig. 5 : Cabin-fuselage of the SUC. 10

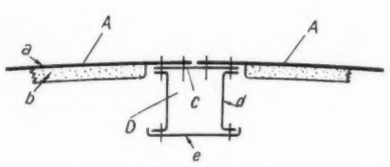


Fig. 6 : Assembly of side panels A with supports D :

A Steel sheet panels a and sponge ebonite b, joined by means of a strip of sheet c (four rows of spot-welds).

D Supports constituted by two U-section spar webs d and a cap e (two rows of spot-welds) ; the sheet strip c serves as second cap.

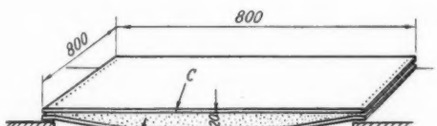


Fig. 7 : Cabin floor L of " sandwich " construction

a Lower surface formed from a folded Vedal sheet
b Sandwich of sponge ebonite
c Protective covering of 0.6-mm aluminium

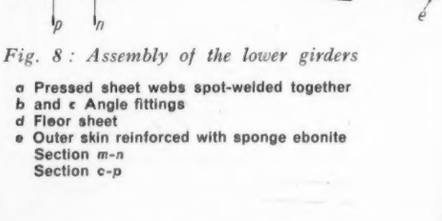
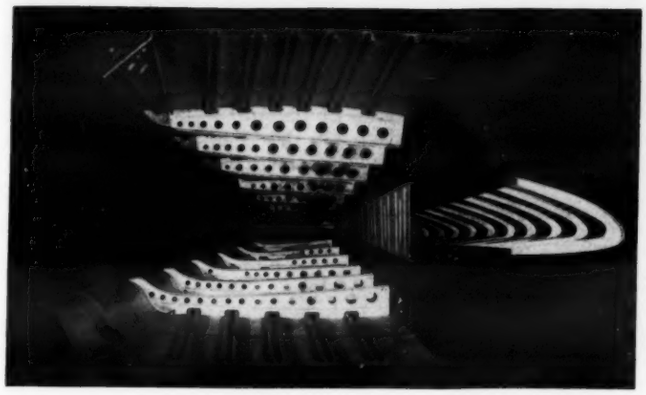


Fig. 8 : Assembly of the lower girders

a Pressed sheet webs spot-welded together
b and c Angle fittings
d Floor sheet
e Outer skin reinforced with sponge ebonite
Section m-n
Section c-p

On the other hand, these SECAN compound plates can be manufactured much more cheaply than the classical plates, especially in the case of large series. The steel panels are manufactured in presses with the aid of a matrix and a rubber cushion ; they are



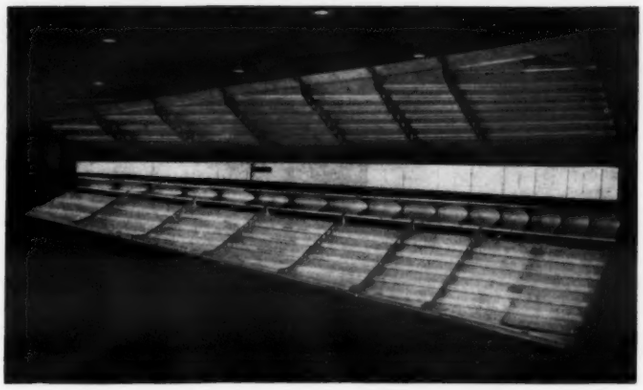


Fig. 10 and 11 : Structure of the wing centre section

attached under low pressure, a liquid bonding medium of cellulose acetate being used. Such compound panels are ready for immediate utilisation ; the open edges of the sheet metal may be spot-welded together with the aid of a strip of copper. This operation in no way impairs the ebonite, as the amount of heat liberated during spot-welding is very small. The exterior of the coque is perfect and its surface is smooth and correctly cambered. Another advantage of the system is that the layer of sponge ebonite does not only reinforce the metal, but also heat-insulates and soundproofs the cabin.

A coat of paint applied to the ebonite suffices to give the cabin a clean appearance. For luxury versions, an additional fabric covering can be applied to the ebonite.

Figures 5 to 8 show the application of this procedure in the construction of the cabin fuselage of the SUC.10.

In the case of certain panels of the cabin which are subjected to greater stresses (back wall and adjacent side walls), the sponge ebonite is sandwiched between an outer sheet of steel and an inner sheet of Vedal alloy.

This type of panel is also suitable for use as a fire wall, since the sponge ebonite can fulfil the same insulating rôle as the layer of asbestos used in classical constructions. The fact that light alloy sheet can be cemented to sponge ebonite also enables this sandwich system to be used for manufacturing floor sections (Fig. 7).

In the very few instances were the spot-welding clamp cannot be introduced into the assembly, ordinary rivets are used. However, the entire cabin fuselage features only 150 ordinary rivets, as compared with 12,850 spot-welds.

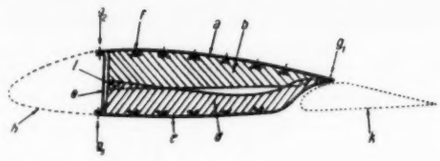


Fig. 9 : Outer wing box-spar

a Upper surface	f Stringers (spot-welded to skin)
b Upper surface half-rib	g Rows of rivets
c Lower surface	h Detachable leading edge
d Lower surface half-rib	k Aileron
e Spar	l Rivets

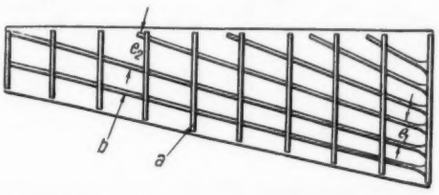


Fig. 12 : Arrangement of stringers on the outer wing skin

a Half-ribs b Stringers

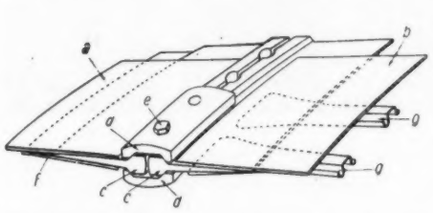
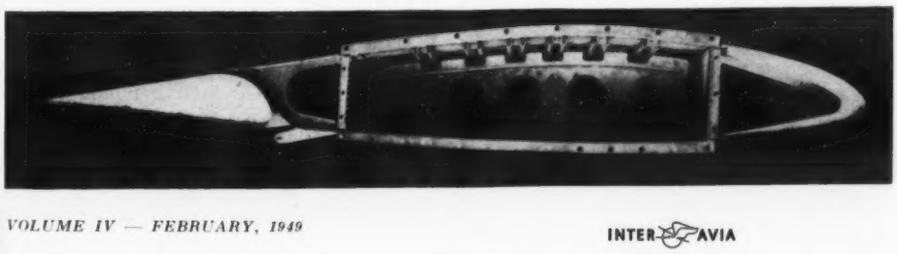


Fig. 13 : Joint between outer wing and centre section. The two members c, profiled in accordance with the aerofoil section of the wing and riveted to the two upper surfaces a and b of the wing elements, are clamped between the two members d which are held together by bolts e. A local reinforcement f is added to one of the panels ; on the other, the flattened extremities of the stringers g are riveted directly to the profiled members.

Fig. 14 : Structure of the wing centre section



2. *Wing*

The structural method involving pressed sheet steel and cemented sponge ebonite as stiffener was utilised only for the cabin. As the aircraft has a low surface loading and the stresses on the wing upper and lower surfaces are small, the use of steel was not indicated. As has been shown above, the weight of such a structure can only be compared with a reinforced light alloy construction if the stresses on the light alloy require it to be at least 1.0 mm. thick. However, in order to keep within reasonable limits the weight of the wing for an aircraft such as the one described here, a large portion of the wing covering must feature different thicknesses, going as low as 0.6 mm. even when light alloy is used.

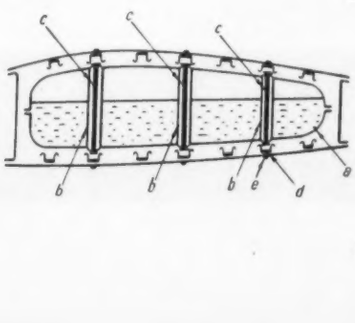
Vedal was therefore chosen as main constructional material for the wing. One of the essential advantages of this alloy is its anti-corrosive properties, eliminating the need for painting the interior surfaces.

A. *Outer Wing*

As shown in figures 9 to 12, each stressed-skin outer wing is built up of a box spar, a detachable leading edge, and a split-type aileron. The actual box is made up of three parts : the upper surface *a*, the lower surface *c*, and the spar *e*. The upper and lower surfaces are assembled separately, being spot-welded to their stringers *f* and half-ribs *b* and *d*. The covering consists of three panels whose thickness decreases towards the wing tips, in accordance with the pressure and the tensile forces which the skin and the

Fig. 15 : Installation of the fuel tanks in the centre section

a Tanks	d Supporting cushions
b Supporting tubes	e Nuts
c Tie bolts	



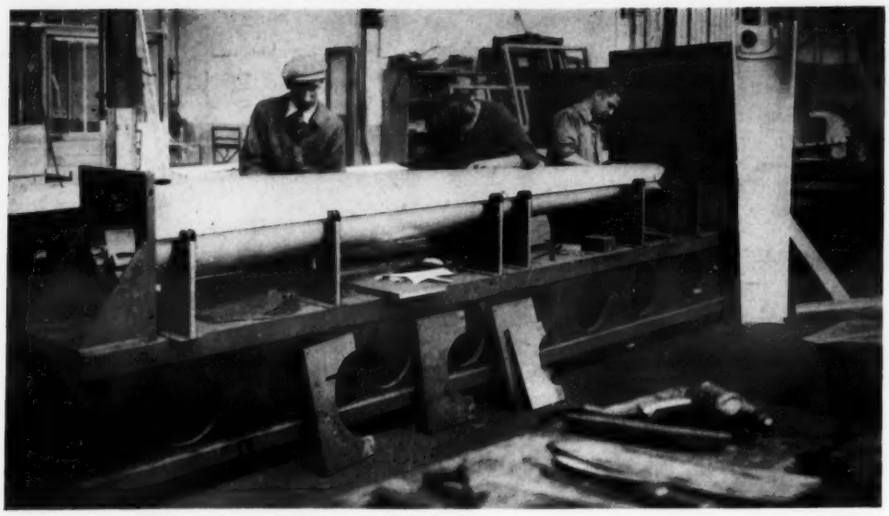


Fig. 16 : Assembly of a tail boom from two half-coques of Vedal spot-welded together

stringers have to support. The stringers are not parallel to each other, but are arranged so as to fan out towards the tips (distances $e^2 > e^1$; Fig. 12), thereby augmenting the stiffening effect and the overall area of the stringers towards the wing root, whilst the tip, where the stresses are smaller, becomes lighter. The half-ribs, of pressed iron sheet, are of Z-section ; one of their edges is bent down and spot-welded to the skin.

At the wing tips the pairs of half-ribs are replaced by one-piece pressed ribs, to which the skin is fixed by conventional rivets.

A single spar, which is a simple strip of sheeting reinforced by vertical beads and having two folded edges, transmits the shear forces and adds to the torsional resistance of the box assembly, though without sharing to any great extent in the bending loads.

For assembling the box spar, the upper and lower wing surfaces are first placed in a fixture in such a way that the corresponding half-ribs overlap. The pairs of half-ribs belonging together are then fastened by three rivets (*e* ; Fig. 5). Subsequently, the panels are riveted at their trailing edges, at *g*, and after the spar has been introduced, the assembly is completed by riveting its folded edges at g_2 with the upper surface and at g_3 with the lower surface. Since these rows of rivets are outside the box assembly, they are easily accessible. The leading edge then is fastened on by means of bolts.

The joint between the outer wing and the centre section was carried out in the first versions of the SUC. 10 by means of bolts, with angle sections terminating the wing platings. This system was extremely costly and far from aerodynamically perfect. It was later replaced by a new system (Fig. 13), which assures easy and rapid assembly and endows the joint with a certain amount of flexibility as the contacting surfaces of the two sections marked *c* are curved. On the other hand, the forces are transmitted almost in the plane of the skin, so that the latter is not subjected to any additional bending moments.

Fig. 17 : Structure of a rudder and stabiliser unit

a and b Spars
c Rear support
d Pressed sheet ribs
e and f Riveted butt strips
g Edge sections
h Rudder

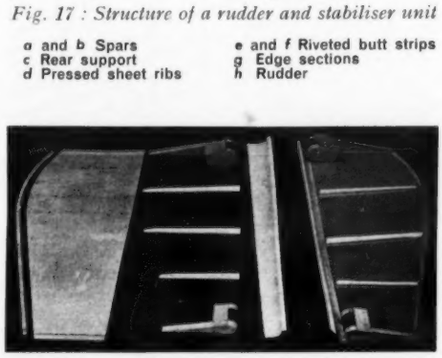
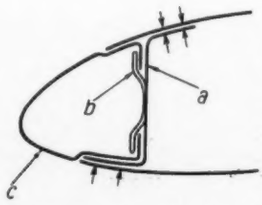


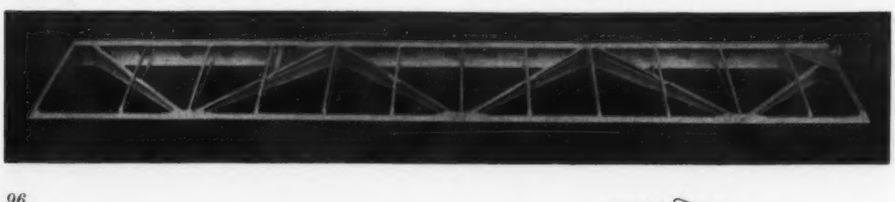
Fig. 18 : Elements of a rudder



a Spar
b Guiding section
c Nose

Fig. 19 : Leading-edge of the horizontal stabiliser

Fig. 20 : Elevator without skin



B. *Wing Centre Section*

The wing centre section takes the form of a box beam (Fig. 14) built up of four main parts : upper surface, lower surface, front and rear spars.

The upper and lower surfaces feature the same structure as the outer wing, except that the half ribs are joined in each case by two Simmonds nuts. For assembling, the extruded edges of the top-hat spars are riveted to the upper and lower wing surfaces, whilst the leading edge and a special trailing edge are bolted to the box beam.

Each of the fuel tanks located in the centre section (Fig. 15) is equipped with a series of sealed-off supporting tubes ; tension bolts, featuring screw threads at their ends, enable the tank to be held firmly between the upper and lower wing platings. Thus the tank, with its interior supports, fills the part of the absent wing ribs and simultaneously finds itself stiffened and held in place by this manner of attachment.

3. *Tail Booms and Empennage*

The two tail booms consist of conical tubes with developable surface. It has therefore been possible to build them up from two semi-coques of rolled and beaded Vedal sheeting (Fig. 16), their respective flanges being spot welded together. There are no bulkheads or longitudinal stiffeners.

The fins, whose construction is discernible from Fig. 17, are welded with butt strips to the extremities of the tail booms.

As is shown by Fig. 18, the rudder consists of two coques reinforced by half-ribs, sealed by spot-welds along its trailing edge and along an external flange at the leading edge. The uppermost and lowest ribs, which are one-piece constructions, carry the hinge mechanism.

The horizontal stabiliser features the same structure as the wing centre section, except that the upper and lower platings are spot-welded to the two pressed spars, and the leading-edge section (*c* in Fig. 19) is pushed along two grooves *(b)* attached to the front spar.

The elevator (Fig. 20) is the only part of the aircraft featuring a fabric instead of a metal covering. A single actuating lever is located at the end of the surface, and in order to transmit the torque moments from it over the entire control surface, the structure comprises six diagonally-laid ribs which come together at the front spar and at the trailing edge. Above them is a set of ribs running in flight direction, which maintain the contour and support the fabric covering.

Studying the Flying Qualities

By Hans BRÜCKNER, Senior Pilot, Vienna

The flight qualities indicate how an aircraft behaves in and after certain definite flight conditions. They reveal themselves " externally " as movements in space, " internally " as forces exerted on the controls, and as travel of the controls and ancilliaries. Whereas the flight performance data can be precalculated reliably and are simple to control afterwards, this is far more difficult in the case of the flying qualities, which are dependent upon more complex factors ; the position of the centre of gravity, distribution of the masses, dimensions of the control surfaces, construction of the controls, power plant installation and other characteristics have a decisive influence.

Up to 1936 the flying qualities were judged solely on the basis of the pilot's " feelings. " Consequently, it was necessary tediously to translate the pilots' statements into technical language, and this could, of course, lead to frequent misunderstandings. Since then endeavours have been made to establish *numerical values* for determining the desired flight behaviour and—according to the particular use for which the aircraft is designed—to classify them on the basis of experience.[1] The fundamental requirements underlying examinations of flying qualities are :-

a) A quantitative assessment of all the important flying qualities and their classification according to the particular use for which the aircraft is designed (Class I for very manœuvrable aircraft, Class II for the others).

b) Prescription of the test procedures in such a manner that clear results will be obtained, which can be repeated by fairly experienced pilots.

c) Immediate determination of the causes of deficiencies, in order that the engineer may know how to remedy them.

d) Selection of values to be measured which are compatible with the possibilities of measurement ; and maximum restriction of measuring equipment.

While executing the flight tests it is profitable to differentiate between two categories :-

I. Flight tests which are only meant to give a general idea of the flying qualities, and which can be carried out with the usual airborne instrumentation : *basic flight test.*

II. Quantitative flight tests in a narrower sense, for judging the controllability, lateral stability, variation of longitudinal moments due to crabbing, etc., which call for an elaborate array of automatic recording instruments for measuring the dynamic pressure, angular velocities, control forces, etc. : *measured flight test.*

The paragraphs which follow deal chiefly with flight tests of the first kind.

1. *Flight conditions and reference velocities :* The examination of the flying qualities embraces both normal and exceptional flight conditions. Every flight condition calls for a definite engine output (and propeller position) and a corresponding state of the airframe (gross weight, undercarriage position, flap position, etc.) ; either the furthest forward or furthest rearward position of the centre of gravity may be critical.

In principle, every aircraft must evidence, at all speeds between the specific stalling speed and the placard diving speed, as well as in all operational altitudes, sufficiently safe flying qualities. A number of characteristic speeds, meanwhile, are of greater significance :-

Cruising speed at the prescribed continuous engine output and flight altitude ;

Climbing speed at maximum rate of climb (on climbing output) ;

Approach speed (on instruments) with flaps in prescribed position, undercarriage down and continuous engine output ;

Gliding speed with engines idling, undercarriage and flaps down.

2. *Controllability :* Every aircraft should be safely controllable in all normal flight conditions and it should be possible to manœuvre it smoothly from one flight condition to another, without having to impose exaggerated demands as regards skill, attention and physical effort on the pilot, and without exceeding the maximum applicable loads. Therefore, the controllability is on the one hand a yardstick for the feasibility of flight movements, on the other for the efforts of the pilot when moving the controls. It divides up as follows :-

a) The *control effect* must be able to compensate the changes in moment arising in flight and give the aircraft the ability to achieve certain angular velocities, according to the purpose for which it is designed.

b) The *control response* characterises the delay to which an aircraft is subjected in order to attain its control effect. It is governed on the one hand by the characteristics of the control surface and rods in question, and on the other by those of the entire aircraft ; and it frequently represents a difficult problem. Thus it can happen that deficiencies occur as a result of delays in the building-up of the new flow after a deflection of a control surface, or of a sogginess of servo controls, " softness " of the push-rod system, large moments of inertia, etc. or as a result of aerodynamic moments (aileron yawing moments, rolling-yawing moments). Bad response mostly leads to an over-control of the flight movements by the pilot, and is therefore very disadvantageous.

c) The *control forces* should be in direct relation to the control effect, in order to give the pilot sufficient " feel. " In principle, they should be kept as small as possible, though under the condition that they be large enough to warn the pilot of any excessive strain on the aircraft. Finally, they must be adjusted to one another, as the pilot has the natural urge " to take the least line of resistance. " Hence the rudder forces—in accordance with the rougher movements and forces of the feet on the pedals—should be the largest, and the aileron forces should be the smallest ; the elevator forces should lie between the two.

3. *Trim and balance :* " Trimming " signifies the reduction to zero of a mean control force which is necessary for keeping the aircraft on a straight flight path at a given speed. The weight, the reactions of the wing, empennage and engines must then be in equilibrium with reference to one of the three axes ; if the pilot leaves the corresponding control free, the trimmed flight condition should remain on the average the same. In this case, the other controls should be actuated only in such a way that the flight equilibrium about the trimmed axis is not influenced by aerodynamic coupling with another axis. If, after some time, the trimmed flight equilibrium with the free control is permanently disturbed, it means

[1] " Richtlinien für die Beurteilung der Flugeigenschaften, " Erprobungsstelle Rechlin, 1936 ; NACA Technical Reports Nos. 715 etc. ; ICAO Documents 3031 (AIR/181) and 2013 (AIR/69).

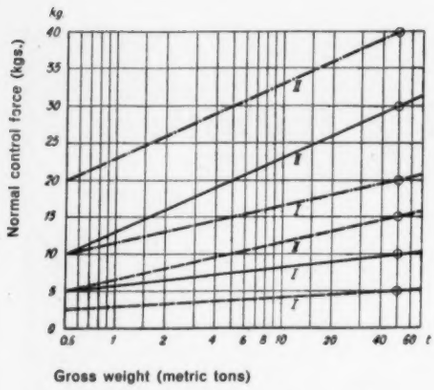


Fig. 1 : Reference values for judging the maximum permissible elevator, aileron and rudder forces (normal control forces as prescribed by the DVL) in function of the operational purpose and gross weight of the aircraft. Certain multiples of the normal control forces should not be exceeded during take-off, landing, climb after interrupted approach, and pull-out.

Class I : Especially manœuvrable aircraft (personal and fighter aeroplanes)

Class II : Other aircraft

Elevator force : full line
Aileron force : dotted line
Rudder force : dot-dash line

that the balance has been changed. This can stem from (1) changes in the position of the aircraft's centre of gravity (*e.g.* as a result of fuel being consumed), (2) altered aerodynamic forces (actuation of flaps, undercarriage, cooling flaps, etc.) or changes in engine output, or (3) an indirect change of the aerodynamic moments as the result of coupling effects (*e.g.* longitudinal moments due to crabbing).

4. *Stability :* This signifies the ability of an aircraft, if moved by an exterior disturbance from its normal flying attitude, to return to the normal attitude without the pilot having to intervene. The aircraft should have sufficient stability to alleviate the pilot's task, notably during long flights and in bad weather. However, this stability should not be so great as to prejudice the controllability.

In order to determine the *static stability* one uses in the calculations the magnitude of the restoring moment which arises in conjunction with a variation of the aircraft's angle of incidence or yaw ; for the static *longitudinal* stability, therefore, the increase in the restoring moment about the lateral axis when the angle of incidence changes ; and for the static *directional* stability about the normal axis when the aircraft yaws. There is no such thing as static transversal stability in this sense, as a banked attitude does not directly give rise to a restoring moment.

The *dynamic stability* indicates, furthermore, if and after how long the initial flight condition has been restored. The dynamic longitudinal stability embraces the oscillations about the lateral axis of the aircraft, which are also known as phugoid oscillations ; the dynamic *directional* stability, on the other hand, is concerned with coupled yawing and rolling oscillations, as well as spiral movements. *Spiral* stability of an aircraft indicates its ability to return by itself to its initial trimmed straight-flight condition after a disturbance of the angle of bank or yaw.

The Basic Test

The indications of the standard airborne instruments, without altitude compensation, suffice for making a general judgment of the controllability, trim and balance qualities, and stability ; in addition, lines are drawn at ± 20 degrees to the horizontal on the windscreen so that the pilot can judge his angle of bank,[2] and eventually an accelerometer and strain gauges may be used for measuring pull-out accelerations and control forces. Though all precise measurements have to be made during the quantitative tests, the basic test should nevertheless provide a preliminary guarantee that the aircraft can be flown with reasonable safety.

Controllability

1. *Take-off :* Controllability tests are conducted with the centre of gravity in its furthest forward and furthest rearward positions on turf and on hard-surface runways, on take-off power and with the airframe in take-off condition. The wheel brakes may no longer be actuated after the aircraft has started to move. Class I aircraft should be able to take off in a straight line when a side-wind (from right or left) of up to 35 km./hr. is blowing, whereas no side-wind conditions are prescribed in this connection for Class II aircraft. With the trimming foreseen for the take-off, the control forces should not exceed the values indicated in Fig. 1. In the case of aircraft equipped with nose-wheel undercarriage, the elevator effect should be sufficient for " unsticking " the aircraft at not more than 110 per cent. of its minimum speed.

2. *Landing :* Here, too, the tests are made with the centre of gravity in its furthest forward and furthest rearward positions ; the aircraft is made to glide to a three-point landing, with the flaps in landing position and the engines idling ; the aircraft must be trimmed for the prescribed gliding speed, which must then be maintained. It must be possible to execute a three-point landing without exaggerated effort (control forces as indicated in Fig. 1) ; the side-wind conditions are the same as for the take-off. If the aircraft is flattened out at too great an altitude—thus at the greatest altitude permitted by the strength of the undercarriage—no dangerous pitching should occur. Aircraft equipped with tricycle undercarriage should touch down at not more than 105 per cent. of the minimum speed.

3. *Climb after interrupted approach :* This manœuvre is carried out immediately after the three-point landing, with all engines furnishing take-off power, and with the position of the flaps and trim tabs corresponding to the gliding approach. Until the aircraft has attained its climbing flight condition, the control forces must be governable without having to resort to re-trimming ; the forces on the aileron and the rudder must not exceed their simple values (Fig. 1), and the elevator force must not be more than double this value.

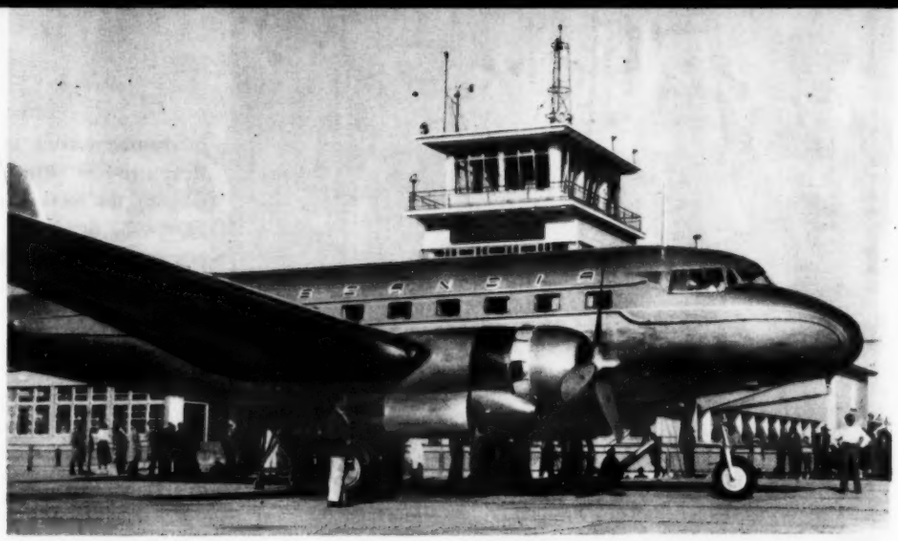
4. *Turning with one control :* With the two other controls left free, curves should be made at constant speeds with only the ailerons or only the rudder being actuated. The curves must be started at cruising, approach and gliding speeds, with the aircraft in the corresponding flight condition. It should be possible to begin and end left and right turns at the angular velocity of the instrument-flight curve (2 deg./sec. = 1 needle width on the turn and bank indicator) ; the flying speed in the curve, with the elevator control free, may not deviate by more than ± 20 per cent. from the trimmed speed for straight flight, and the largest banking angle should not exceed 20 degrees.

5. *Side-Slip :* It should be possible, with the aircraft in gliding condition, to execute a constant-speed straight side-slip with the rudder fully deflected, with the centre of gravity in its furthest forward and furthest rearward positions and the engines idling, whereby the aileron control deflection is noticeable but does not exceed 75 per cent. of the maximum deflection, and the control forces must have a restoring action.

6. *Curves in the case of asymmetrical engine failure :* If those engines whose failure has the most unfavourable effect are cut out on one side, then it should still be possible to execute curves both on the sides of the stationary and running engines with the latter furnishing continuous power, without the banking angle exceeding 20 degrees.

[2] All numerical values indicated from here on correspond to the recommendations of the Deutsche Versuchsanstalt für Luftfahrt (DVL), which may fulfil the present purpose until international regulations have been enforced by ICAO.

(Continued in the next issue.)



During the many demonstration flights made in the latter part of 1948, the "Scandia" visited over a dozen Western European airports.

Saab "SCANDIA"

Among the few twin-engined airliners striving to succeed the proven Douglas DC-3 on European medium- and short-range routes, the Saab 90A "Scandia" developed by Svenska Aeroplan A.B., of Linköping, Sweden, has long stepped out of the ranks of the unknown. It is already three years ago since we first described the design fundaments and constructional details of the "Scandia" in this magazine,[1] and more recently we compared its technical[2] and economical[3] characteristics with those of other presumptive successors to the DC-3.

[1] "Scandia" in INTERAVIA, Review of World Aviation, Vol. I, No. 4, pp. 30-33.

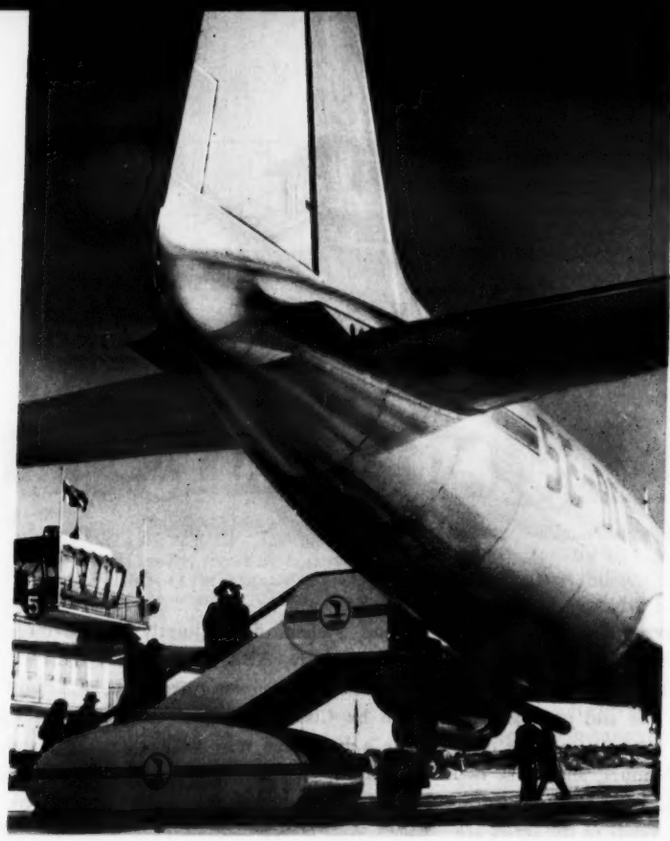
[2] "Twin-Engined Commercial Transports" in INTERAVIA, Review of World Aviation, Vol. III, No. 10, pp. 569-574.

[3] "The Reason for Larger and Faster Airliners" in INTERAVIA, Review of World Aviation, Vol. III, No. 12, pp. 677-680.

The Model 90A-1 prototype, powered with Pratt & Whitney R-2000-2SD13G "Twin Wasp" 14-cylinder twin-row radials, which first took to the air at the end of 1946, has successfully concluded extensive service tests lasting several hundred hours, and work has already begun on the Model 90A-2 production version. The first ten aircraft of the series are to be fitted with the somewhat more powerful R-2180-E12 version of the "Twin Wasp," which furnishes 1,800 H.P. take-off power and 1,400-H.P. METO.[4] They are to be delivered to the Swedish ABA carrier during the course of this year, so that the "Scandia" will soon make its appearance on the far-flung continental network of Scandinavian Airlines System, flown jointly by the three Nordic carriers, ABA, DNL and DDL.

[4] 1,800 H.P. with water-methanol injection, otherwise 1,650 H.P. take-off power at 2,800 r.p.m.; 1,400 H.P. with low impeller ratio at 6,000 ft. and 1,250 H.P. with high impeller ratio at 15,500 feet and 2,600 r.p.m.

The prototype, designated SE-BCA and flown by Claes Smith and Olle Hagermark, made a European tour between August and October, 1948, visiting Oslo-Fornebu, Dublin, Prestwick, London-Gatwick, Jersey, Copenhagen, Amsterdam-Schiphol, The Hague, Brussels, Zurich, Geneva, Lisbon and Madrid. Thus many aviation fans had a chance to examine the cockpit installation, stick their heads into the undercarriage recesses, count the aerials, bombard the crew and demonstration personnel with many questions in different languages, and eventually to fly in the aircraft. It is hoped that the present description and photographs will keep up to date those who did not have the privilege of seeing the "Scandia" in real life.



Clean configuration makes for good flight performance.

The external aspect alone of this all-metal low-wing monoplane of 91 ft. 10 in. span with tricycle undercarriage, makes an excellent impression. The careful configuration of the rear fuselage and of the transition between wing and fuselage speak for an aerodynamally clean aircraft. A comparison of the high take-off weight—30,860 lbs. for the Model 90A-1 prototype and 32,408 lbs. for the Model 90A-2 production version—with the wing area of 922 sq. ft. and the engine power, reveals favourable values for wing loading (33.5 and 35.1 lbs./sq. ft.) and take-off power loading (10.7 and 9.0 lbs./H.P.), which indicate good take-off and landing performance on small or high-altitude airfields, as well as a good rate of climb. For instance, the production version at full gross weight and with water injection can clear a 50-foot obstacle in a take-off run of only 1,935 feet at sea-level, whereas the service ceiling on METO power is either 28,550 ft. or 24,600 ft., depending on the impeller ratio, being combined with a rate of climb of 24.6 ft./sec. at sea-level. These advantages nevertheless enable a high enough cruising speed to be achieved, amounting to about 250 m.p.h. at 10,000 ft. on 67 per cent. METO power.

The engine installation is the result of extensive study. A scoop in front of the undercarriage bay takes in air for the oil coolers and carburettors. It also contains a filter against dust and sand. The opening in the wing leading edge takes in air for the thermal anti-icing system.

It is evident that, in view of this particularly good climb performance, the risk involved when an engine fails during take-off or when flying over mountainous regions is probably not so critical. Even on one engine, a fully-loaded "Scandia" can still climb at a rate of 5.6 ft./sec. and attain a service ceiling of about 10,000 ft.

Meanwhile, the Pratt & Whitney "Twin Wasp" engines—each fitted with an injection carburettor, a single-stage compressor and double magnetos—are so thoroughly proven that such failures during regular operations are extremely improbable. This risk is minimised still more as the manufacturers have given the engine installation much careful thought and have improved considerably on the original installation. The engine nacelles have large cooling flaps aft of the NACA cowl ring, and a scoop which takes in air for the oil cooler and the carburettors. Moreover, if there is danger of icing, the combustion air can be tapped from the engine-cooling air ; or it can be made to pass through a filter system beneath the scoop, to prevent sand and dust from entering the engine. Thus provision is made for anti-icing, drying and filtering of the combustion air, and many origins of possible engine breakdowns eliminated to the best of human ability. It should also be mentioned here that the production aircraft are equipped with Hamilton Standard four-blade hydraulically-adjustable propellers which, having completely reversible pitch, enable the landing run to be shortened appreciably.

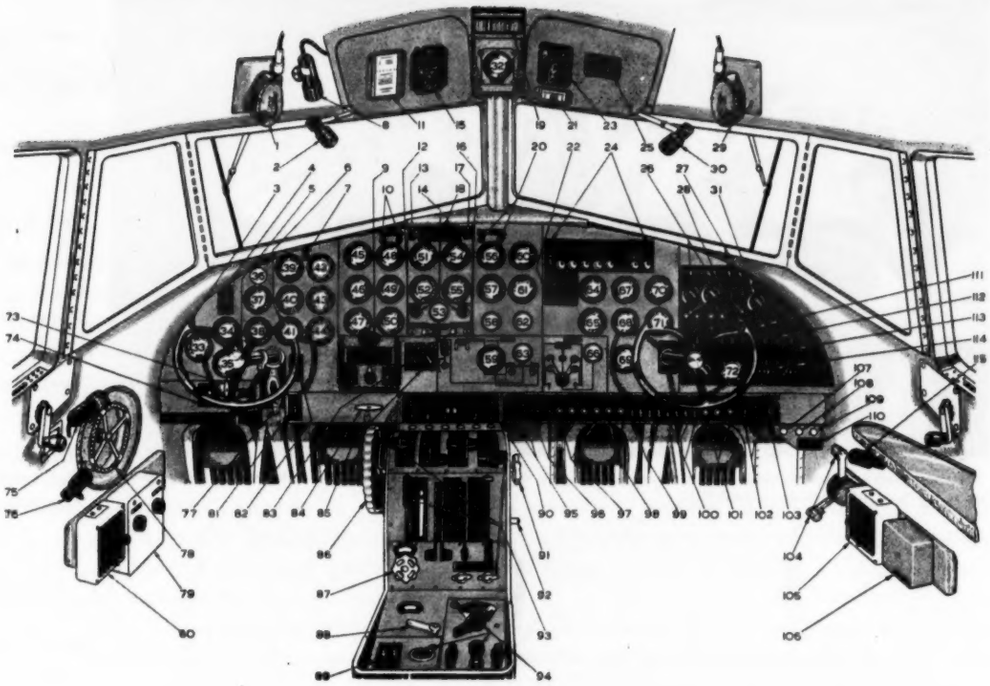
Among other "Scandia" characteristics contributing to a high degree of flight safety are the good stability and manoeuvrability during slow flight, direct operation of the control surfaces without boosting mechanism, and the anti-icing of wing, fin and tailplane leading edges by means of three hot air generators in the engine nacelles and the fuselage rear. The double windshield to the cockpit is likewise de-iced by means of hot air, and the propellers are protected by electrical resistance "boots," so that the "Scandia" can be operated throughout the year, notwithstanding the frequently adverse climatic conditions common to the far-northern regions.

A great deal of attention has been paid to the fire protection system. All four main tanks are located in the outer wings, far away from the cabin and engines, and the fuel can quickly be jettisoned through outlets in the wing tips with the aid of electric pumps. Fire-warning systems and a manually-controlled fire extinguishing system take care of the engines, hot-air generators and cargo compartments. In the case of a crash landing, the fire extinguishing system is actuated automatically.

A glance at the cockpit installation gives further evidence of the designers' efforts to provide maximum safety. Whilst making an impression of extreme simplicity, the instrument panel contains everything necessary for modern navigation : complete blind-flying instruments, ILS, radio compass, Sperry automatic pilot, LF, HF and VHF radio, etc. The latter may be handled via remote controls from the pilots' seats, so that the "Scandia" can be flown by a two-man crew, without radio operator. As a rule, however, a radio operator is carried, and on long routes, a flight engineer also, both sitting aft of the pilots. All flight instruments are installed in duplicate, working independently of one another, and numerous instrument combinations are utilised for engine control. Gust locks are fitted to the control surfaces, a central control being located in the cockpit ; the retractable tail support is also actuated from the cockpit. The main landing wheels and the nose-

Cockpit equipment

1. Gear-box to windshield wiper.
2. Ultra-violet light.
3. Push-buttons.
4. Altitude limit indicator.
5. Electrical release button.
6. Inter-com push-button.
7. Warning light of autopilot.
8. Spotlight.
9. Autopilot control.
10. Fuel pressure warner.
11. Frequency chart for LF/HF radio.
12. Port oil and fuel shut-off.
13. Port engine fire warner.
14. Feathering push-button.
15. Remote controls for radio.
16. Starboard oil and fuel shut-off.
17. Starboard engine fire warner.
18. Engine trouble detector.
19. Deviation chart for compasses.
20. Oil pressure warner.
21. Frequency chart for VHF radio.
22. Undercarriage and door warnings.
23. Remote controls for VHF radio.
24. Fire-warning and extinguisher panel for heaters.
25. Remote controls for ILS.
26. Propeller anti-icing controls.
27. Pitot tube heating controls.
28. Heater controls.
29. Gear-box to windshield wiper.
30. Ultra-violet light.
31. Windshield wiper controls.
32. Magnetic compass.
33. Clock.
34. Altimeter.
35. Altitude limit switch.
36. Marker beacon indicator.
37. Airspeed indicator.
38. Altimeter (aneroid).
39. ILS cross-pointer.
40. Gyrosyn compass.
41. Gyro horizon.
42. Radio compass indicator.
43. Rate of climb indicator.
44. Turn and bank indicator.
45. Fuel gauge for front tanks.
46. Fuel gauge for rear tanks.
47. Outside air thermometer.
48. Fuel pressure gauge.
49. Fuel flow-meter.
50. Carburettor air temperature gauge.
51. Port manifold pressure gauge.
52. Port tachometer.
53. Synchroniser.
54. Starboard manifold pressure gauge.
55. Starboard tachometer.
56. Oil pressure gauge.
57. Cylinder temperature gauge.
58. Hydraulic pressure gauge.

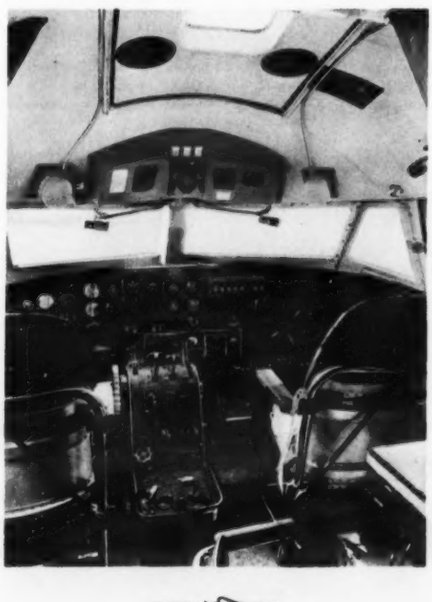


59. Ammeter for DC control panel.
60. Oil temperature gauge.
61. Oil and anti-icing fluid gauges.
62. Brake pressure gauge.
63. Voltmeter for DC control panel.
64. Airspeed indicator.
65. Altimeter (aneroid).
66. Voltmeter for AC control panel.
67. Repeater compass of autopilot.
68. Gyro horizon.
69. ILS cross-pointer.
70. Rate of climb indicator.
71. Turn and bank indicator.
72. Thermometer for heaters and cabin.
73. Parking control.
74. Selector valve for static pressure.
75. Spotlight.
76. Ultra-violet light.
77. Gust lock.
78. Steering-wheel for nose-wheel.
79. Control box for lights.
80. Interphone selector box.
81. Position light switch.
82. Selector switch for gyrosyn compass.
83. Engine fire extinguisher controls.
84. Engaging handle for autopilot.
85. Magneto selector switch.
86. Elevator trimmer.
87. Aileron trimmer.
88. Rudder trimmer.
89. Control switch for landing light.
90. Controls for booster pumps, cowl flaps, carburettor air and fuel shut-off.
91. Friction adjustment knob.
92. Undercarriage control lock.
93. Engine, fuel, flap and undercarriage controls.
94. Remote controls for radio compass receiver.
95. Air filter warners.
96. Carburettor air warners.
97. Starting and priming push-buttons.
98. Oil dilution push-buttons.
99. Cowl flap controls.
100. Oil cooler flap controls.
101. Push-button for fire-alarm testing.
102. Tail support controls.
103. Push-button for bulb testing.
104. Air-conditioning controls.
105. Interphone selector switch.
106. Range filter for radio compass.
107. Control for cockpit heating.
108. Control for aerial anti-icing.
109. Air-conditioning control.
110. Selector valve for static pressure.
111. 112. 113. Light switches.
114. Windshield anti-icing controls.
115. Ultra-violet and spotlights.

wheel retract forwards, so that the entire undercarriage can be lowered rapidly without the aid of a hydraulic system, but simply with the help of the weight and relative wind ; the nose-wheel is steerable. Other noticeable features of the cockpit are the sturdy windshield wipers fixed to the front panel, the adjustable pilots' seats, and an arrangement of the controls which gives the pilots plenty of leg room.

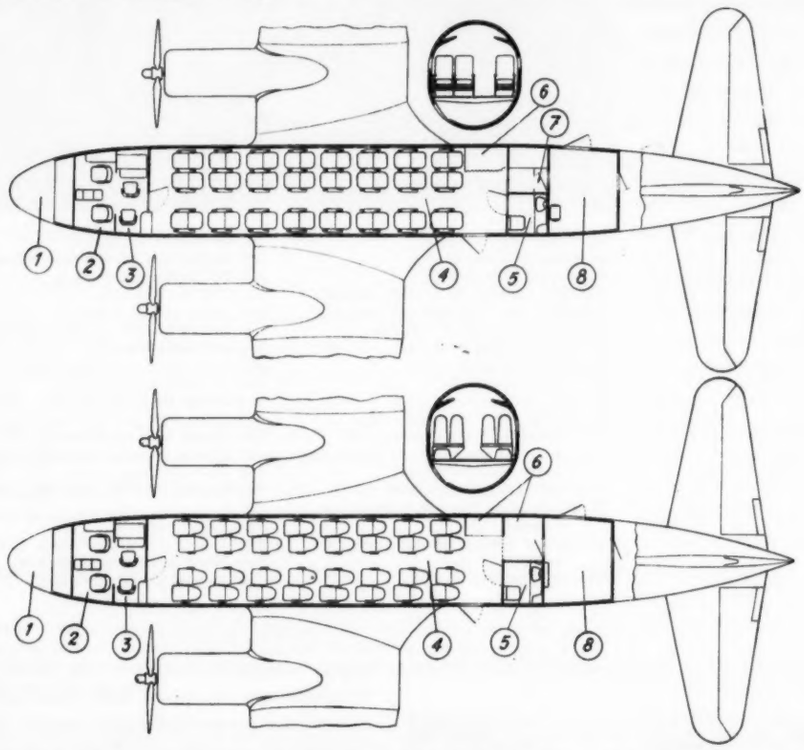
As is the case for every commercial transport, safety is followed by the greatest possible comfort. In this respect, too, the "Scandia"—particularly its medium-range 24-passenger version—leaves nothing to be desired. The passenger space is located symmetrically in relation to the centre of gravity of the aircraft, so that even a rolling motion in unsteady air cannot greatly disturb passengers. The cabin is soundproof, well-ventilated, and agreeably heated. Each row of seats terminates at a large, rectangular window ; the comfortable armchairs are equipped with individual air intakes for air-conditioning, reading lamps, and various amenities. Cabin illumination is novel insofar as it admits daylight through the roof. Large racks for hand luggage, a wardrobe opposite the entrance door, ultra-modern toilet facilities and a well-equipped pantry comprise some of the remaining passenger comforts. The normal range on 60 per cent. METO power, against a 10-m.p.h. headwind and with the stipulated fuel reserve, amounts to 870 miles, thus enough for a non-stop flight from Stockholm to Brussels or Moscow. Greatest range is possibly half as much again.

View of the cockpit. The radio operator's station is behind the co-pilot's seat.



For short-range operations, the armchairs are taken out and replaced by rather less sumptuous seats arranged in rows of four, each pair being slightly staggered. In this way space is provided for 32 passengers, thus

The comfortable passenger cabin is well illuminated in the daytime thanks to windows in the roof. Large rectangular windows offer excellent visibility.



The medium-range seating arrangement for 24 passengers can be replaced by a 32-passenger arrangement for short trips. 1 : Front cargo compartment ; 2 : cockpit ; 3 : radio operator's (and flight engineer's) station ; 4 : passenger cabin ; 5 : toilet ; 6 : wardrobe and luggage compartment ; 7 : pantry ; 8. rear cargo compartment.

Over Swedish forests and lakes.

combining with the lower fuel supply to increase the "Scandia's" economic value over short routes.

Dimensions, Weights and Performance of the Saab 90A-2 "Scandia"

(Pratt & Whitney R-2180-E12 "Twin Wasp" engines)

Dimensions :

Span	91 ft. 10 in.
Length	69 ft. 11 in.
Height	24 ft. 3 in.
Wing area	922 sq. ft.
Total cargo capacity	389 cu. ft.

Weights :

Max. take-off weight	32,408 lbs.
Max. landing weight	31,967 lbs.
Tare weight	20,608 lbs.

	24-pass. version	*32-pass. version*
Passengers (without luggage)	4,080 lbs.	5,440 lbs.
Crew (with luggage)	543 lbs. (3-man) 737 lbs. (4-man)	387 lbs. (2)
Buffet and passenger service equipment	229 lbs.	115 lbs.
Residual fuel and oil	188 lbs.	188 lbs.
Fuel, oil, and pass. luggage	6,760 lbs.	5,670 lbs.
765 U.S. Galls. fuel and 58 U.S. Galls. oil	5,080 lbs.	5,080 lbs.

Comparative values :

Max. wing loading	35 lbs./sq. ft.
Take-off power loading	9 lbs./H.P.
METO wing power	3 H.P./sq. ft.

Performance :

Max. speed	
2,800 H.P. at sea level	262 m.p.h.
2,800 H.P. at 6,000 ft.	278 m.p.h.
Cruising speed	
1,880 H.P. at 10,000 ft.	250 m.p.h.
Landing speed	
30,200 lbs. landing weight, flaps down, sea level	75 m.p.h.
Rate of climb at sea level	
32,408 lbs. take-off weight, 2,800 H.P.	24.6 ft./sec.
32,408 lbs. take-off weight, 1,400 H.P.	5.6 ft./sec.
Service ceiling with 32,408 lbs. take-off weight, METO power,	
high impeller ratio (1,250 H.P. at 15,500 ft.)	28,550 ft.
low impeller ratio (1,400 H.P. at 6,000 ft.)	24,600 ft.
Take-off run to clear 50-ft. obstacle, at 32,408 lbs. take-off weight and 3,600 H.P. take-off power	1,935 ft.
CAR take-off runway length	3,690 ft.
Landing run to clear 50-ft. obstacle, up to standstill, at 31,967 lbs. landing weight	1,770 ft.
CAR landing runway length	2,950 ft.

The "Scandia" can also be supplied with a pressurised cabin, if desired. Such a version, which would be known as the Saab 90B, would probably not be used for short-range operations, but would certainly increase the block speed appreciably where medium-range routes are concerned.

"Flying Wings" in Production

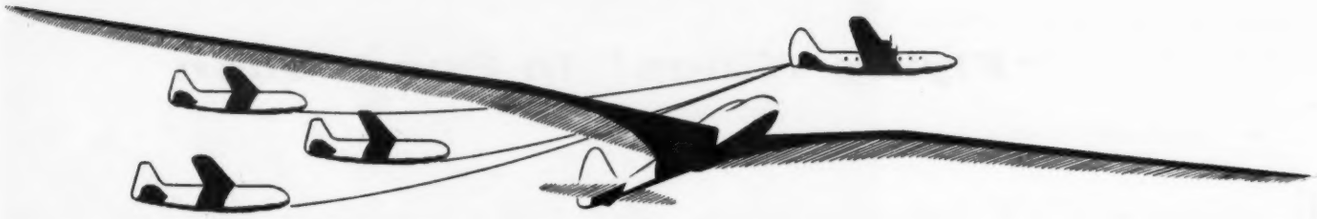
The configuration and size of the Northrop B-49 "Flying Wing" are too remarkable to have escaped public notice. Less well known, however, is that already more that half a dozen units exist of this monster spanning 172 feet and grossing 200,000 lbs., and that the manufacturer has orders for another 30. Although the initial order from the U.S. Air Force was for thirteen XB-35 conventionally-powered versions and only two jet-propelled models (of which one has crashed), the results of more recent flight tests have led to a reversal of this situation : ten of the B-35s are being converted to B-49s, in that their four propeller-engines are being replaced with eight turbo-jets. The reason is as follows. Whilst the gearings to the contra-rotating propeller pairs caused such difficulties that the engines had to be fitted with simple four-blade propellers, jet-propulsion has fulfilled, if not surpassed, all expectations. Last summer a B-49 even accomplished a nine-hour test flight, covering nearly 3,500 miles at altitudes between 35,000 and 40,000 feet.

Hence, almost the entire B-35 fleet of the U.S. Air Force is now being converted. The accompanying photo shows nine of these aircraft lined up on the Northrop factory airfield at Hawthorne, the field measuring 195 by 550 feet ; two additional units are visible in the background. It is thanks to the tailless conception that they do not take up more space, for it would not be possible to park more than four conventional aircraft of corresponding size on the same area.

Work on the thirty additional "Flying Wings" has already begun at Consolidated Vultee Aircraft Corporation's factory at Fort Worth, Texas. Fitted, of course, with turbo-jet power plants, their precise designation is RB-49 (RB standing for reconnaissance-bomber), since they are designed chiefly for medium-range reconnaissance flights involving aerial photography from great altitudes, and for light-bomb attacks.

Despite jet propulsion's conclusive victory over the ordinary propeller-engine, John K. Northrop is by no means convinced of this latest prime mover's practical utility in the next ten years for long-range operations.

In a recent lecture in Washington, he did not conceal his opinion that the "Flying Wing" would be most economically powered with propeller-turbines, and that jet propulsion should be confined to high-speed fighters, medium-range bombers, and winged bombs. And on the test bench at the Turbodyne Corp., a Northrop subsidary, trials are proceeding with a propeller-turbine whose output of 10,000 H.P. is today attained by only the biggest turbo-jet engines at extremely high speeds.



Motorless Flight

Better Performance with Tailless Sailplanes

BY WALTER M. HORTEN, GÖTTINGEN.

Walter Max Horten, at present 35 years old, was only nineteen when he first started building tailless aircraft together with his younger brother. He has since developed about twenty different types of sailplane and aeroplane of tailless design, which have made his name known internationally.

A study of present-day sailplanes reveals a certain standardisation which, in principle, is bounded by two proven limit solutions. On the one hand, certain types are built for low sinking speeds accompanied by low flying speed, and on the other, designers often aim at especially good gliding qualities accompanied by higher flying speeds. A brief glance at the different types of sailplane reveals the influence exercised by these qualities.

a) *Duration flight* is of only secondary importance from the standpoint of technical development. Almost all known types of sailplane whose flight characteristics, strength, roominess and visibility conditions meet with modern demands are suitable for this branch of soaring flight. Slope up-currents, especially over dune areas where the wind is steady (thus along most coastlines), provide the most favourable conditions for duration flight ; and sailplanes featuring a small span, low sinking speed and good manoeuvrability represent the best type of flying equipment for this purpose.

b) *Altitude flight,* interesting from both the sporting and meteorological standpoints, sets quite contradictory demands as regards the type of sailplane to be selected, as it may have to be executed in radically different types of weather : for instance on thermal up-currents with cumulus formations, which can ultimately develop into strong storms ; or in Foehn conditions in mountainous regions, where use is made of up-currents in lee waves. High-performance thermal flight, and especially storm flight (which, in view of the necessity for blind-flying in very gusty air, should only be carried out by very skilled pilots) appear, from the technical standpoint, as a sort of "flying on the spot," which does not demand anything special in the way of gliding performance. On the other hand, flying in lee waves calls for a sailplane capable of flying fairly rapidly in strong altitude winds without losing too much height. Therefore, whereas a low sinking speed is advantageous in thermal and storm flight, flying in lee waves calls for sailplanes with an exceptionally good gliding angle.

c) *Distance flight* must also be feasible in all kinds of weather conditions. For instance, a pilot can cover distances by continually circling in the thermal up-currents of the wind, thus travelling in a similar manner to a free balloon. In weather conditions like this, even sailplanes with a low sinking speed can enable good results to be achieved. In the event of no-wind conditions, a sailplane with a good gliding angle is better equipped for distance flight. The pilot circles on the spot, gains height, and translates this into distance. In this connection, it is a known fact that the absolutely best gliding angle is not the only important factor, but that a good gliding angle at high flying speeds is equally as important.

d) *Distance flight with fixed goal* and distance flight with return to the point of departure represent two of the most difficult tests for a soaring pilot, as they often call for good gliding performance against headwinds. Accordingly, pilots and sailplanes are really put to the test. A good gliding angle at high flying speed is especially important here, but fairly good performance at low flying speed is still essential.

To sum matters up, it may be said that, for thermal flight, a sailplane having a low flying speed and a low sinking speed is better equipped for gaining altitude, but for distance flight it is necessary to have a machine which reveals a good L/D ratio at high speeds. If the aim is to endow a sailplane with as wide a field of operation as possible, then it is necessary to unite the two limit conditions,

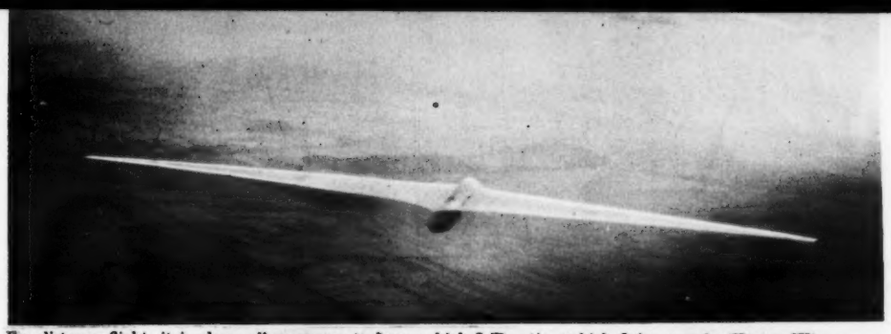
Circling in narrow up-wind currents calls for low sinking speed in slow flight, and small curving radius (Horten IV).

thus giving rise to the problem of finding a good compromise solution.

Meanwhile, this compromise solution is by no means easy to find. Circling in narrow thermal up-currents does not only demand a low sinking speed at low flying speed, but also the ability to curve as tightly as possible, in order to be able to remain in the centre of the up-current. With the lift coefficient remaining constant and the angle of bank being given, the curving radius is proportional to the wing loading, which means that a low wing loading enables a sailplane to negotiate tight curves. On the other hand, it is necessary to have a high wing loading for distance flight in order that the path speed, despite the favourable gliding angle, may be high, especially against headwinds. Consequently, when comparing sailplanes from the standpoint of performance, one should not only take their dimensions into account (in other words their span) but also their wing loading.

It is mentioned here that my brother and I have endeavoured, since 1931-32, to improve the performance of sailplanes by a method other than the classical one—namely by building tailless sailplanes. We began by building types having especially low sinking and minimum speeds, as well as a small curving radius (Horten II and III), and later adopted designs which also aimed at a high L/D ratio in the high-speed range (Horten IV, VI and XIV). The accompanying polar curves (sinking speed versus flying speed), plotted for speeds actually attained, clearly illustrate the course of this development. The first-named types have been repeatedly described in various national aeronautical magazines, so that we shall confine ourselves here to later types, designed principally for high-speed flight.

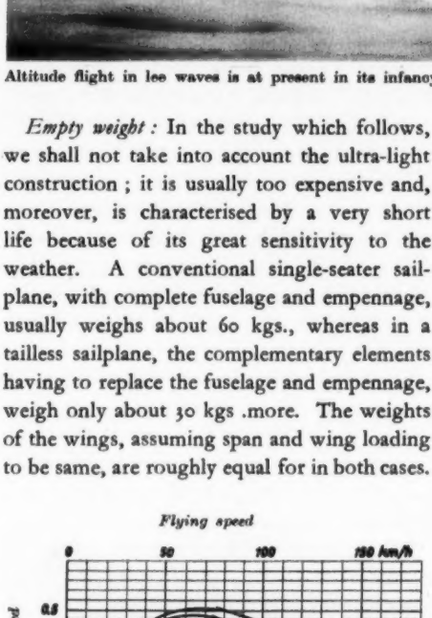
Why was the choice given to tailless design, and what advantages does this type provide over conventional sailplanes featuring the same span and wing loading ?



For distance flight, it is above all necessary to have a high L/D ratio at high flying speeds (Horten IV).

Altitude flight in lee waves is at present in its infancy.

Empty weight : In the study which follows, we shall not take into account the ultra-light construction ; it is usually too expensive and, moreover, is characterised by a very short life because of its great sensitivity to the weather. A conventional single-seater sailplane, with complete fuselage and empennage, usually weighs about 60 kgs., whereas in a tailless sailplane, the complementary elements having to replace the fuselage and empennage, weigh only about 30 kgs .more. The weights of the wings, assuming span and wing loading to be same, are roughly equal for in both cases.



Polar curves of the Horten III, IV and VI sailplanes, designed by the Horten brothers, reveal the progress made. (The Horten XIV is a training sailplane.) The points of best L/D ratio are plotted on the polar curves.

The balance shows, therefore, that the tailless sailplane is about 30 kgs. lighter than the conventional design, which means that, for the same span and wing loading, it has a *higher aspect ratio.*

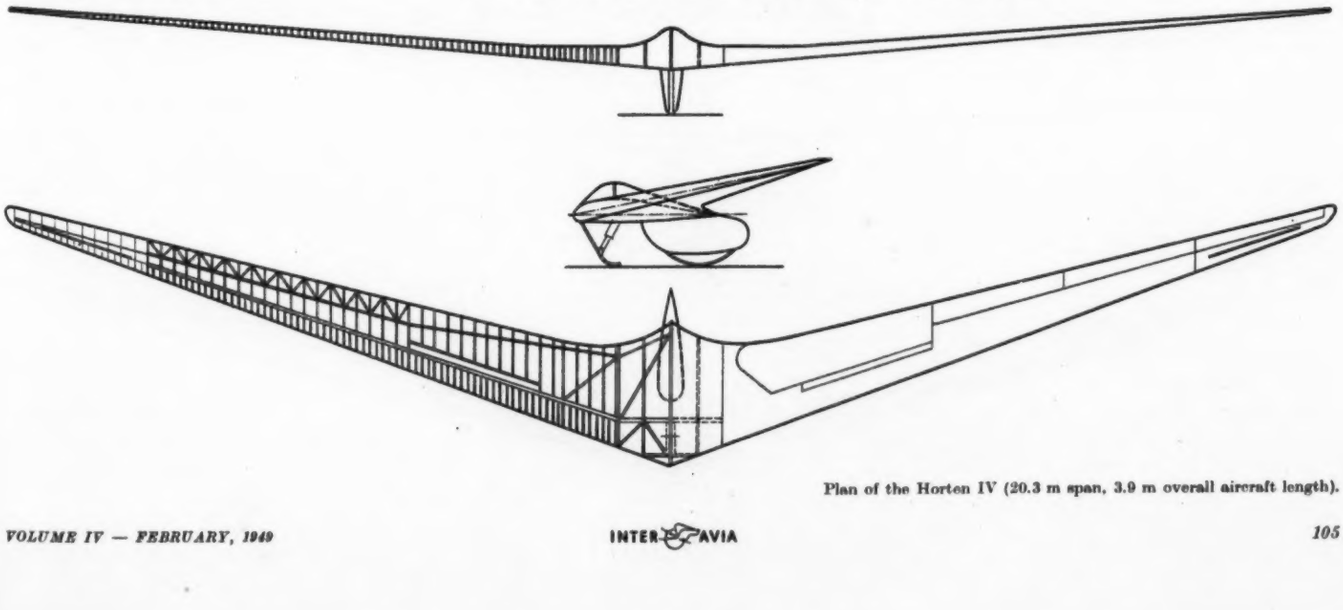
Slow flight : In slow flight, a higher aspect ratio provides decisive advantages. The lowest sinking speed, which is especially important in this field, may be calculated according to the relation :

$$v_s = \sqrt{\frac{2}{\gamma}\,\frac{g}{}\,\frac{G}{S}\left(\frac{C_D^2}{C_L^3}\right)_{opt}}$$

The reciprocal value of $(C_D^2/C_L^3)_{opt}$, which could be called the "climbing index," can be calculated in approximation, according to Klemperer, in function of the aspect ratio (A) and the coefficients for parasite drag (C_{Do}) and profile drag (C_{Dp}) :

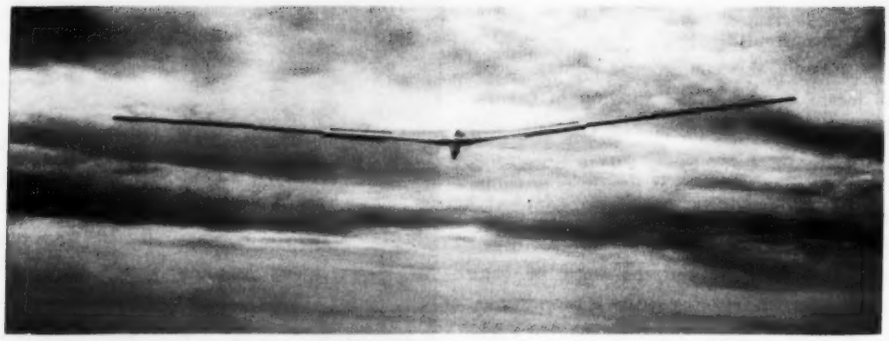
$$\left(\frac{C_L^3}{C_D^2}\right)_{opt} = 1.8\sqrt{\frac{A^3}{C_{Do}+C_{Dp}}}$$

The advantage of the tailless sailplane is therefore clear : higher aspect ratio reduces the sinking speed.



Plan of the Horten IV (20.3 m span, 3.9 m overall aircraft length).

The Horten IV, one of the world's highest performance sailplanes, was developed in the years 1939-40.



With dive brakes extended, the flying speed of the Horten IV is "unlimited"—a further safety factor in cloud flight.

Fast flight : The L/D ratio, which is the most important factor in this respect, is determined by the drag coefficient alone, if one presupposes that the lift coefficient is constant in view of the unequal wing loadings of the two sailplanes under comparison ; the drag coefficient represents the sum of the coefficients of induced drag, profile drag and parasite drag. Since the lift coefficient is small at high speed, the induced drag is of little importance ; the coefficient of profile drag is the same for both sailplanes. On the other hand, the parasite drag furnished by the tailless design is appreciably lower, as there is no drag originating from the friction and form of the fuselage and empennage.

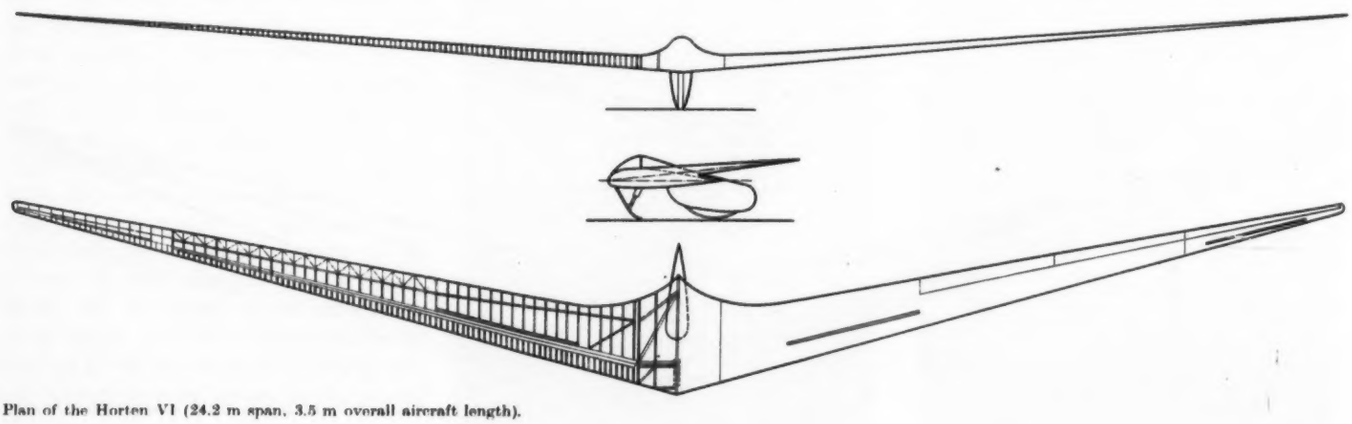
This explains why much better performance can be expected of a tailless sailplane at slow and fast speed, than from a comparable sailplane of conventional design. Furthermore, to enable the performance to be stepped up by reducing the parasite drag (thus by reducing the frontal area), a semi-prone position was chosen for the pilot of the Horten IV and VI types. In this position, the upper part of the pilot's body is inclined at about 30 degrees to the horizontal, which leaves the head in a fairly comfortable position.

This position for the pilot has received praise during several hundred flights, especially during duration flights of over ten hours. Pilots, once they have become used to it, even prefer this position, for it gives them a better "feeling" of the aircraft and because it is physically less tiring if the weight of the body is supported by a greater area ; it largely corresponds to a bird in flight. With regard to high speed projects, it is interesting to note that the prone pilot is considerably less sensitive to high accelerations than a seated pilot. The photos and drawings reveal that the ideal "all-wing" concept has been approached very closely, even to the point of housing the pilot.

Based on these considerations, the Horten IV was evolved in the years 1939 and 1940, when five units were built. Developed for distance soaring, this type attained a very high performance level, having been tested in extensive flight trials of over 1,000 hours.

Its five sub-assemblies—a centre section of welded steel tubing, two single-spar outer wing sections of wood, and two wing tips of dural—enable it to be transported easily in small trailers. It can be assembled by three persons in five minutes. The centre section is joined to the main wing sections by means of conical bolts which are so conceived that no special tools are necessary. The same applies to the wing tips, which are fastened to the main wing sections by means of simple attachments. All the push rods for actuating the controls are also equipped with quick-fastening attachments. In this way, the designers have satisfied a demand which is of great importance to practical operations, and especially during competitions.

The wing centre section, 1.60 metres wide, contains the trough for the pilot and supports the undercarriage, consisting of two skids arranged one behind the other, of which the front one is retractable and the rear one fixed. The latter is flexibly mounted through the aid of a rubber cable and a lever system, in such a way that when the sailplane lands, the shock-absorbing element is varied only very slightly in distance, whereas when the load increases, the "spring travel" becomes very large. The ratio of transmission therefore varies progressively, so that a pleasant shock-absorbing characteristic is provided. For the front skid, an oleo-pneumatic telescoping shock absorber is utilised. The skid is retracted manually through the aid of a wire cable and the weight of the skid is used for lowering it, whereby a spring locks the leg when it is fully extended. When a winch or tow launch is made, a wheel mounted in a fork is fastened under this skid, and falls away automatically when the skid is retracted after the take-off. The trough for the pilot is manufactured from elektron sheet and padded with a two-centimetre-thick layer of sponge rubber covered with leather. It can be pre-adjusted in size to suit the pilot, and may be evacuated without difficulty if he has to bail out. The pilot need



Plan of the Horten VI (24.2 m span, 3.5 m overall aircraft length).

only make one movement to jettison the cockpit canopy and simultaneously release his safety belt, whereupon the parachute jump can be made towards the rear, unimpeded by any parts of the aircraft. An automatic parachute is located in a metal pocket of the canopy, but a manual parachute can be utilised if desired. The elevators and ailerons are actuated by means of a steering wheel of which the shaft slides on ball bearings, and by rods supported on bearings. Small air brakes for yaw control, at the wing tips, are actuated by pedals. Large dive brakes enable the sailplane to dive at angles up to 60 degrees.

The single-spar outer wing sections are built of wood and each carry two control surfaces. In addition to the above-mentioned air brakes, the wing tips each carry an aileron-type control surface. All dimensions were chosen in accordance with the German DVL regulations (H 5 group of strength specifications). With the dive brakes extended, the speed is "unlimited" ; in horizontal flight, if the weather is very gusty, it should not be allowed to exceed 145 km./hr., although a higher cruising speed can nevertheless be attained.

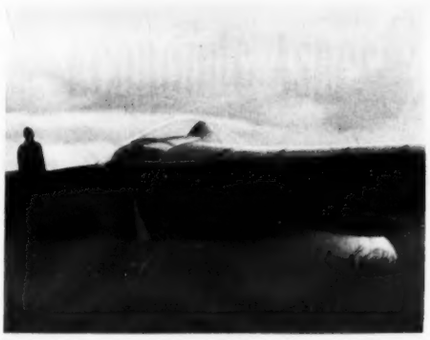
The Horten VI was designed as a research sailplane and therefore given an exceptionally high aspect ratio (1 : 33). Two units were built in 1943, and the single-seater Model VI possessed the same structural features as its predecessor, the Horten IV, and performed extraordinarily well during its tests in September, 1944. The flying qualities were also satisfactory, so that it could very well have been flown in lee waves of high mountains, as intended. However, political developments cut its career short.

Dimensions, Weights and Performance

	HORTEN IV	HORTEN VI
Span	20.3 m	24.2 m
Wing area	18.9 sq. m	17.5 sq. m
Aspect ratio ..	21.2	33.0
Empty weight .	240 kgs.	320 kgs.
Gross weight .	330 kgs.	410 kgs.
Wing loading .	17.5 kgs./sq. m	23.4 kgs./sq. m
Taper ratio ...	5	6.25
Lowest sinking speed	0.54 m/sec.	0.48 m/sec.
Best L/D ratio	37 : 1	43 : 1

Data on flight performance are contained in the polar curves.

Both aircraft types behaved extremely well during the tests and proved during measured flights that they were capable of attaining the design performance values. The Horten IV might be considered as almost the ideal sailplane for the meteorological conditions common to the Central European latitudes. Featuring a wing loading of 17 kgs./sq.m, it curves



The Horten VI research sailplane, built in 1944, was designed for wave flight over mountainous regions. The wheel located beneath the front skid is automatically jettisoned when the skid is retracted.

very easily in narrow thermal up-currents and, despite its span of twenty metres, promises good altitude gains in view of its low sinking speed and good manoeuvrability. It outclasses all present-day sailplanes thanks to its extremely good gliding qualities, so that it could be used to achieve record performances which have hitherto been unattainable.

Although the Horten VI is probably too advanced for ordinary soaring practice, as it demands rather high skill from pilots, those who are interested in really high-performance soaring may note that it revealed itself to be far superior in all speed ranges to the Horten IV. It is certainly with justice that one can call it the world's highest performance sailplane to reach the goal set by its designers : a research sailplane for considerably widening the limits hitherto common to soaring flight.

For the sake of completeness, it is mentioned that, alongside these highly successful designs, a further sailplane type of the same design and providing the same position for the pilot was built in the years 1944-45 : the Horten XIV training sailplane, adapted to the "Olympia" class. With a span of 16 metres, a wing loading of 14 kgs./sq.m and an aspect ratio of 16, it was designed to have a minimum sinking speed of 0.66 m/sec. and an optimum

The Horten VI, whose performance exceeds by far that of the Horten IV ; lowest sinking speed, 0.48 m/sec. at 65 km./hr. ; optimum L/D ratio, 43 : 1 at 88 km./hr.

L/D ratio of 30 : 1. The aircraft was completed before V. E. Day, but could no longer be test flown. It was also planned to build a second version with a laminar-flow aerofoil, in order to obtain comparative values on the laminar effect.

The way towards superior performance in soaring by utilising laminar-flow aerofoils, still lies ahead. In this connection, account would have to be taken of the small profile thickness and the stringent demands as regards surface finish ; and last but not least, care should be taken that the present high-class flying qualities are not be affected.

What further possibilities remain as regards improving the performance of sailplanes—eventually in conjunction with tailless design ?

a) The further increase of the wing aspect ratio, which is the classical method and has repeatedly been applied up to the limits of constructional and static possibility, seems to have been exhausted today.

b) Another method, which consists in using a more cambered aerofoil section in slow flight than in rapid flight, has been attempted in different ways by using camber flaps, but the effective gain in performance frequently does not correspond to the calculated gain, as a break in the profile contour causes, in practice, a considerably higher increase in drag than is assumed theoretically. However, if it were technically possible to change the camber of an aerofoil in a continuous manner, then this method could probably give rise to far more efficient results. The constructional problems are nevertheless difficult, and the solution must not be accompanied by any substantial increase in weight. Utilisation of laminar-flow aerofoils therefore seems to promise greater success. Even though it may be coupled with difficulties, this way is certainly faced with better prospects. A laminar-flow aerofoil cambered for slow-flight conditions also has very small drag coefficients in the high-speed range. Keeping the wing loading low, designers could in this way fulfil the two basic conditions of soaring flight : low minimum sinking speed and good L/D ratios at high flying speed.

Nowadays we can therefore very well imagine sailplanes of small span—thus relatively inexpensive—revealing exceptional performance abilities, notably in conjunction with tailless design. True, a certain amount of preparatory work will have to be accomplished before designers can pass to the realisation stage, but it is to be hoped that soaring flight and private flying, too, will be given a wider scope than hitherto. And one of the best ways of reducing the present high cost of flying as a sport is certainly to improve the flying equipment.

The Air Hostess Told Us...

Every Cloud has a Silver Lining...

Air lifts have become chronic and are spreading, Esmeralda says, remembering her dream of last month. The whole screwy system is growing to be like one of those giant Sequoia trees of California, which are so big they need at least two men to look at them, one from the ground to the middle and the second from there up, with a possible third for the ramifications.

Well, reports our Favourite Air Hostess, the old Sequoia isn't doing so well these days, at least not so far as its trunk is concerned. Both the American and British portions of the Berlin trunk seem to feel the strain. The vital spare parts which are required to keep the aircraft flying are increasingly difficult to get, and the weather interferes whenever the Ivans don't. And while the knocking down of the two radio pylons near Tegel airfield in Berlin has doubtlessly removed two obstacles which might have been pretty sticky in murky weather, the demolition seems to have done everything but clear the atmosphere.

However, every cloud has a silver lining, for someone or other at least, although most people have learnt to be content with paper money since the war. This is not too bad, of course, provided you get enough of it. Anyway, the silver-paper lining of the cloud of aircraft making up the air lift was discovered several months ago by fifteen Poles, who diverted an attractive proportion of the goods landing at Tempelhof airport to the Berlin black market. They were arrested by the Americans early in November, at the psychological moment when they were getting ready to ship some of their earnings—about a ton of silver and large stacks of banknotes—by air to Frankfurt. Now, it is a well-known fact that men refuse to learn from the experience of others. This general rule received another confirmation in an announcement that in the second December week the British had arrested eighty-two Germans at Gatow Airport, Berlin, for shunting "between three and ten percent of packed consumer goods" arriving at the field to the ex-capital's black market.

"Hitler Fought a Helluva War"

Obviously, incidents like these, coupled with the fatigue of non-stop flying in all sorts of weather and a cold war which is getting hotter all the time, do little to strengthen the morale of the pilots running the air lift, especially those who are not quite sure why they are in Europe anyway. Pilots are getting increasingly browned off. Operation Vittles morale has reached a record low point at Fassberg, the big Anglo-American air base in the British Zone, which hauls the highest proportion—62 percent—of the total tonnage crossing the Russian Zone into Berlin. Fassberg is situated in bleak countryside, miles away from anywhere, and so much in the sticks that the Allies never knew it existed until the end of the war. The nearest hick town is two hours away by road or rail. Apart from the location, the fishy stare of British breakfast kippers seems to have been the major single contributing factor to the growing tendency of the lower American echelons of throwing in the towel. Morale got so bad that the USAF decided to send a special team of experts around to find out what was wrong. Our omnipresent Air Hostess went with them, of course.

They found that even the British griped, although they haven't been spoiled for several years. Their chief complaint was that the Germans around Fassberg were eating better than the British in England (which may have something to do with the *cuisine*...). Some of the Americans, on the other hand, said they did not quite see the point of the air lift, especially as the Germans did not seem to appreciate it. "First you bomb them, then you feed them..." What do you think of the Germans in general ? "We've never found a single Nazi or anyone who as much as knew a Nazi. For a guy who was all by himself, Hitler fought a helluva war..." Perhaps the Russians appreciate the real value of the air lift more than the pilots who fly it. One pilot told Esmeralda about the air lift in reverse. Last summer, shortly after a batch of Fairchild C-82 "Packet" cargo transports had arrived in Germany, it was discovered that the machines were being used primarily to cart about five hundred American-owned automobiles from Berlin back to the Western Zones, presumably because there isn't much gasoline in Berlin for joy-riding. One of the "Packets" was steadily droning along one day, with the rear doors off (as has become the custom on this supply operation) and carrying a lovely, brand-new, shiny Buick convertible. Suddenly one of the engines quit and the crew found it difficult to maintain altitude. Pilot and co-pilot started a profound discussion. "Shall we or shall we not," they wondered, "chuck the thing out ?" They finally decided to keep it and made their aerodrome safely, proud of the fact that they had saved the car —for cars are still at a premium even in the United States. Esmeralda grins when she thinks of what might have happened if they had decided otherwise. In particular, she would have like to see the face of the German Michel upon discovering that an American aircraft had dropped a $2,500-automobile C.I.F. his chicken run. His appreciation of the Americans would have soared sky-high, for a nation that supplies poor peasants with motor-cars must indeed be powerful. On the other hand, the careful German mind might have been critical of the mode of delivery.

Olive Branches.

The busiest of the three fellows looking at the Sequoia would be the one watching the ramifications, says Esmeralda, the girl with a heart of—plutonium, which seems to have succeeded gold as the most precious of metals. In fact, our Favourite Air Hostess claims, the old tree is sprouting an occasional olive branch. What could be more peaceful than the special BOAC "Constellation" air lift they organised to carry Charles Philip Arthur George's (the Prince's, of course)—photographs to New York on December 15th, or the U.S. Army's decision to have about 4,000 German war brides hauled to the U.S.A. by PAA, TWA, AOA, SAS and other lines before the U.S. War Brides Bill expired on December 27th ? *Bl.*

Economic Aspects

Recovery Year for the U.S. Airlines

Written prior to the P.A.A.-A.O.A. fusion, this article by our U.S. economic correspondent comes as a logical supplement to our leading article (Pan American Airways takes over American Overseas Airlines). Whereas the latter article describes the special position of Pan American Airways System with respect to intercontinental air traffic, the following paragraphs explain why American Airlines is the leader in the domestic field.

Responsibility for the accuracy of the favourable considerations given to the economic characteristics of two U.S. airliners (DC-6 and "Convair-Liner") must rest with the author.

The Editor.

The airline industry in the United States has a way of setting records. Not only has it built itself into the largest and most efficient system in the world, but it has established a veritable record for getting into trouble. Getting out of trouble is not going to be as exciting and colourful as the build-up, which has increased U.S. air travel six-fold in a decade. But the men who run the airlines and the personnel of the Government agencies which have jurisdiction over them now have the tools in their hands which can reconstruct the battered finances of the country's air carriers. Whether these tools will be properly used depends upon the human capacity for co-operation and compromise.

The breach in the dike which must be repaired is large : the official tabulation of operating losses for the two years ended last June 30th shows a deficit of $38,000,000. Although this figure has been considerably reduced by tax credits, it demonstrates the size of the post-war misfortunes which have befallen air transportation. During the final half of 1948 there were, at best, meagre earnings to mitigate the unhappy results of the previous twenty-four months.

The long-term debt of the domestic carriers has risen to nearly $180,000,000, whereas there was virtually none before the war. Some of this money has gone to buy new equipment, but much of it has been poured into unprofitable operations. And now the winter season, with its inevitable train of temporary deficits, is under way.

American Airlines, Inc. — The Airline Moses?

If in this wilderness of red ink there is an airline Moses who might lead the tribe to more sunny climes, it is probably American Airlines. This is said with all due respect to Captain Eddie Rickenbacker's Eastern Air Lines, which has made money right along and so has not had to stage a recovery.

American, or any other airline, cannot of course do it alone, as the co-operation of the Civil Aeronautics Board must be enlisted, as will be discussed later in this article. But American has shown evidence of setting the pace, although its leadership is not prompted by quite the same motives which inspired Moses, but rather by an instinct for self-preservation and a determination to stick to the programme it has laid out. American had some luck, too, both good and bad, although its good luck did not prevent net losses of about $3,000,000 in 1947 and of nearly $4,000,000 in 1948.

American's claim to leadership is two-fold, but in only one aspect is it unique. This unique aspect is the determination to replace completely the Douglas DC-3 and DC-4 aircraft upon which many other lines still depend for much of their revenues. This year American will eliminate its DC-3s, and will probably stop using DC-4s except for cargo. Its fleet will consist of 50 new DC-6s and 75 twin-engined "Convair-Liners."

It is estimated by American that it costs only 2.8 cents to produce a seat-mile of capacity on a DC-6 and 3.7 cents on a "Convair-Liner," in a period of active traffic such as last September. This is an average of 3.25 cents a seat-mile. But the old DC-3s cost 5.5 cents a seat-mile and the DC-4s, 5.2 cents, although the short depreciation period of the latter tends to keep the cost fairly high. This means that a fleet of DC-3s and DC-4s would require a passenger load factor of between 80 and 90 per cent. to break even, whereas the new fleet could break even with a 54 per cent. load factor. These estimates are based on a fare of 6 cents a passenger-mile, which will probably be the average first-class fare for 1949.

These break-even load factors will be increased, of course, by special round-trip discounts, but they will be improved by increased revenues from air mail and from the rapidly increasing air cargo department. (During the first nine months of 1948 air cargo ton-miles were up 140 per cent. over the same period of 1947.) These estimates support the predictions of American's management that the line may be able to achieve an all-year-round break-even point of 60 per cent. or less (which takes into account the influence of the winter season).

The second phase of American's claim to leadership is in its attack upon operating costs. Other carriers are also actively reducing costs, but American's efforts have apparently been the most successful. The peak of post-war inefficiency, brought on by a general over-estimation of traffic potential and a consequent surplus of personnel, resulted in the employment in 1946 of 7.05 persons by American for each 10,000 miles of available capacity. By 1947 this payroll had been cut to 5.68 employees and by last September to 4.47 employees.

The economy process continues. Part of this saving, of course, was from the new DC-6s and "Convair-Liners," but much of it came from careful weeding out of needless jobs and improving the output of the people who remained. Definite proof of results came in October, when the company was able to earn a substantial amount of money.

During the final two months of 1948 losses were held to a minimum. This is in sharp contrast to the losses of recent years in the final quarter, brought on partly by the cold weather and partly by such mishaps as the grounding of the DC-6 aircraft in November, 1947.

No other domestic air carrier has replaced many of its high-cost DC-3 transports. Northwest Airlines will go a long way towards it in 1949, however, with a combination of its twin-engined Martin transports and the new Boeing "Stratocruisers" due for delivery fairly soon. But United, T.W.A., Eastern, Capital, Delta, Braniff, Chicago & Southern, and Colonial will still be using the outmoded DC-3s in 1949. Western and Continental have bought some "Convair-Liners," but have not completely renewed their air fleets.

American's mere example will not, of course, provide the money for the others to purchase new flying equipment. Capital requirements for such aircraft are at least $125,000,000. But most of the carriers are heavily in debt for the four-engined airliners such as the "Constellations," DC-6s and DC-4s. These four-engined types are all that is keeping the heads of most carriers above water. But American had the good luck, and the good management, to do its own major financing in the nick of time, just before the credit of the airlines suffered an eclipse beginning at the end of 1946.

Influences to Improve Credit

The other aspect of the airline picture, namely the attitude of the Civil Aeronautics Board toward mail payments, must be settled before airline credit can be re-established. But this picture is becoming brighter. There is a growing recognition in Washington that the concept of commercial air transportation engendered by the war years was false. The reduction of mail rates to conform with the wholly transitory traffic and earnings pattern of 1943 through 1945 is now realised to have been an error. So is the over-expansion of routes insisted upon by the airlines themselves and granted by the C.A.B.

Airline traffic, which had been envisioned as going up forever as the stock market was in 1929, has hit at least a temporary ceiling. Traffic has not fallen off much (only about 3½ per cent. in 1948, as compared with 1947), but earnings fell nearly as fast as did the prices of stocks twenty years ago.

The C.A.B. has evidenced a recognition of this situation in granting additional mail pay to certain "need" carriers. Chicago & Southern, Delta, and Braniff, were the first to be so treated. But the crucial point of the mail pay situation will be reached when, within the next month or two, the Board hands down the "big five" decision, involving American, United, T.W.A., Northwest and Eastern. The temporary rates awarded last April increased the per-ton-mile payments to an average of nearly 65 cents, whereas all but Northwest, which was on a 60 cents per ton-mile basis, had been getting only 45 cents previously.

But this award, which gave the five carriers more than $5,000,000, did not prove sufficient, and all five have pressed strongly for even higher rates. This claim is not materially affected by the recent Court decision against mail payments retroactive prior to the date of application.

The basic argument of the carriers has been well set forth by Carleton Putnam, Chairman of Chicago & Southern Air Lines. Mr. Putnam insists that the Civil Aeronautics Act for 1938 is a mandate for the Government, through the C.A.B., not only to provide for air postal service, but for air commerce in general and for considerations of national defence. Mr. Putnam, analysing the cost of the airlines to the taxpayer, finds that the true "added cost" to the Post Office to date for handling air mail has been $54 million less than the money received from the sale of air mail stamps. This does not, however, take into account Post Office overhead expense allocated to air mail, nor the theoretical share which the airlines might have borne in the building of airfields and other ground facilities.

But his point is well taken, and seems to be gaining recognition in Washington.

There is thus a good chance that when the "big five" decision comes down, it will recognise this public-service aspect, and provide enough mail pay to cut some of the 1948 losses and permit a reasonable profit to the more efficient lines from then on. Pre-war mail rates were much higher than today, or even rates which the Board may soon grant. To approach the pre-war figures would only be a recognition of an essential historical continuity. At least that is the argument of Mr. Putnam and other airline leaders, including W. A. Patterson of United.

There are still other factors in the airline panorama which promise ultimately to help strengthen the industry's basic structure. For example, a second-class passenger service may be tried this year on a fairly extensive scale. Capital Airlines initiated such a service in 1948, followed by Northwest Airlines. Success to date of these services, which charge only 4 cents a mile instead of 6, indicates a considerable potential ahead. Special "family plans," granting low rates for the first part of the week when traffic normally is slack, have also proved successful and may be extended this year.

Cargo traffic continues to rise, and is assuming an important place in the airline revenue total, although still small in relation to passenger revenue. Air parcel post, if properly promoted, also promises to provide increased revenues. Further, there is a steady improvement in air navigational facilities, which is reducing flight cancellations during bad weather.* A complete solution of bad weather air navigation and traffic control (R.T.C.A. Programme) is probably at least ten years away, however.

Still another favourable factor is the possibility that during the coming year some of the more uneconomical routes will be bolstered by airline mergers or route consolidations. The C.A.B. has set out to foster such consolidations, and the airlines themselves are well aware that there is too much competition over certain sectors.

There is certainly no quick and easy way for *all* the airlines to restore their earning power and credit standing. The C.A.B. cannot undertake to underwrite all the mistakes and bad luck which the air carriers may experience. But the Board has it in its power to establish a renewed opportunity for good management to make money by flying aircraft. The answers should not be long in coming, and by the middle of 1949 there is a good chance that the air carriers will be breathing easier and planning ahead for earnings rather than deficits.

Frederick Peters, New York.

* INTERAVIA, Review of World Aviation, Vol. IV, No. 1, pp. 19-20.

Official Bulletin of the F.A.I.

FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

The International Commission of Aeronautical Sport of the F.A.I. met in Paris from September 27th to 28th, 1948. After having ratified the homologation of the records submitted to the F.A.I. since its last meeting, the Commission examined the following proposals :

International Aerological Commission : The Commission of Aeronautical Sport decided to replace the Aerological Commission with a technical sub-committee which will be composed of three to five members chosen from well qualified scientists who will be known as "F.A.I. Experts." These experts will be appointed for a period of at least two years, initially from French scientific circles. They will later be elected from scientists of the other member countries of the F.A.I.

Modification of record regulations : A new set of rules and regulations, proposed by the Royal Aero Club of Great Britain, which will call for extensive modifications of the "Code Sportif," will have to be examined in detail by the national aero clubs before it can be considered by the Commission.

Distance records : The Commission of Aeronautical Sport has decided to recognise distance records between certain cities in countries which are members of the F.A.I. The existing regulations will be nullified and replaced by a new set. The General Secretariat will publish the new text and it will be incorporated in the "Code Sportif."

Classification of light aircraft : The former classification according to the cylinder capacity of the engines has been replaced by the following new classification according to aircraft gross weight :

1st	Category		0 kgs.	to	500 kgs.
2nd	"	over	500 kgs.	to	1,000 kgs.
3rd	"	over	1,000 kgs.	to	1,750 kgs.
4th	"	over	1,750 kgs.	to	3,000 kgs.
5th	"	over	3,000 kgs.	to	4,500 kgs.

Classification of light seaplanes : The former classification has likewise been replaced by a new system :

1st	Category		0 kgs.	to	600 kgs.
2nd	"	over	600 kgs.	to	1,200 kgs.
3rd	"	over	1,200 kgs.	to	2,100 kgs.
4th	"	over	2,100 kgs.	to	3,400 kgs.
5th	"	over	3,400 kgs.	to	5,000 kgs.

Utilisation of jettisonable fuel tanks : The Commission has decided to authorise the utilisation of jettisonable fuel tanks in record attempts of all categories.

New soaring records proposed by the International Gliding Commission : The Commission of Aeronautical Sport has decided to recognise institution of an absolute altitude record, but stipulates that the difference between two successive records must be of at least five per cent. On the other hand, the Commission points out that the accuracy with which soaring records are measured, should be improved so as to be on a par with the accuracy required for measuring aeroplane altitude records. This question is now in the hands of the technical sub-committee recently established by the Commission of Aeronautical Sport.

Speed record over 100-kilometre triangular course : The Commission of Aeronautical Sport has likewise agreed to the institution of this record, but stipulates that the difference between two successive records must be of at least 2 km./hr.

Prince Georges Bibesco Trophy : The Commission of Aeronautical Sport has decided to reduce to six months the originally stipulated delay of fifteen months between the publication of the competition regulations and the actual competition. The Commission has likewise decided to suggest to the Aero Club of France a reduction of the northern part of the itinerary foreseen for the competition, and to include one or two sections over Spanish territory. Finally, the Commission suggests eliminating from the competition regulations the 600-kg category for single-seater aircraft. As for the rest, full liberty is given to the aero club entrusted with organising the competition.

F.A.I. licence for parachutists : The Commission has decided simply to nullify the existing text.

Next meeting of the Commission of Aeronautical Sport : In view of the urgency of a new and definite "Code Général Sportif," it has been decided that the Commission should meet again in Paris next April or May, at which time the Paris Salon will take place.

RECORDS HOMOLOGATED BY THE F.A.I.

World Record

Speed over 3-km. course (U.S.A.)
Major Richard L. Johnson, U.S.A.F.,
15th September, 1948 :
1,079.841 km./hr.

International Record — Class C

Speed over 3-km. course (U.S.A.)
Major Richard L. Johnson, U.S.A.F.
North American F-86 monoplane
General Electric J-47 turbo-jet
Muroc, California, 15th September, 1948 :
1,079.841 km./hr.

Women's Record — Class D

Duration (France)
Miss Marcelle Choisnet
Air 100 sailplane, No. 5
Romanin-les-Alpilles,
17-18-19th November, 1948 :
35 hr. 3 min.

Book Reviews

Jet Propulsion in Commercial Air Transportation. By Robert E. Hage. Princeton University Press, Princeton, New Jersey, 1948. 91 pages and 41 diagrams.

Although, or precisely because, the present requirements of the airline companies as regards flying equipment seem to be covered, and the aircraft manufacturers are more concerned with armament contracts, jet propulsion for commercial transport aircraft is today a subject of lively discussion.

The author of the present book (representing the first series of Edwin G. Baetjer II Memorial Lectures at Princeton University), having been entrusted with examining this question while Senior Group Engineer in the Preliminary Design Section of the Boeing Airplane Company, comes to the conclusion that a medium-range turbo-jet transport is an extremely likely development for use on U.S. continental routes by the end of 1950. In formulating his opinions, he does not lose himself and his readers in abstract theory, but carefully takes into account the level at present attained in engine development, the direct and indirect operating costs, the characteristics of the route network, etc. Clearly understandable charts for comparing reciprocating, propeller-turbine and turbo-jet engines, together with a generally utilisable grouping of assumptions for weight breakdown, parasite drag and operating costs, bear witness to a consistent calculation of many designs.

The fact that the gradual conversion, not fully recognisable one or two years ago, of the U.S. aircraft manufacturing industry from civil to military construction, and certain progress since made in propeller-turbine design, might affect the fulfillment of some o the author's prognostics, in no way undermines the contents of his book ; on the contrary : until research and practice have answered the question, the argument remains open, and such an animated contribution becomes even more valuable. *T.*

The Month in Review

COPYRIGHT BY INTERAVIA *

AVIATION POLITICS

● A civil aviation agreement is being negotiated between Great Britain and Mexico.—Negotiations between India and Iran have resulted in a provisional civil aviation agreement : an Indian and an Iranian airline will jointly fly the Teheran—Bombay route via Zahidan and Karachi.—Negotiations for an Argentine-Swiss civil aviation agreement are proceeding in Buenos Aires : it is expected that the Argentine FAMA will be authorised to operate to Switzerland and Swissair to Argentina.—A Franco-Egyptian civil aviation agreement is expected to be concluded shortly.—Negotiations are taking place for the conclusion of a civil aviation agreement between Italy and India, and similar talks are likely to be started between Italy and Pakistan.—Scandinavian and Belgian airline officials as well as Sabena and SAS representatives are negotiating an arrangement for temporarily regulating the operation of services between Belgium and Scandinavia.

Berlin Air-Lift :

● The consumption of petrol by British aircraft (R.A.F. and civil) on the Berlin air-lift from June 28th to November 6th inclusive was 30,000 tons.—After withdrawal of all the Douglas DC-3s and two Vickers "Vikings" operated by British charter companies on the Berlin air-lift, the British charter fleet is exclusively four-engined except for three Bristol 170 "Freighters." Aircraft consist primarily of Handley Page "Haltons," Avro "Lancastrians," Avro "Tudors" and an increasing number of Handley Page "Hastings."

FIRST FLIGHTS

● The prototype of the Cierva W. 11 "Air Horse" single-engined helicopter made its first flight on December 8th. The W. 11 is designed to carry 28 passengers or about three tons of freight.

● The Castel-Mauboussin CM. 100 light transport aircraft is undergoing initial flight tests at Aire-sur-Adour. The power plant consists of two 590-H.P. SNECMA 12-S-00 twelve-cylinder in-line engines.

● The prototype of the Chase C-122 twin-engined assault transport developed for the U.S. Air Force made its first flight on November 18th. It is powered with two 1,450-H.P. Pratt & Whitney R-2000 radials. Span is 86 ft. 4 in., length 56 ft., and height 21 ft.

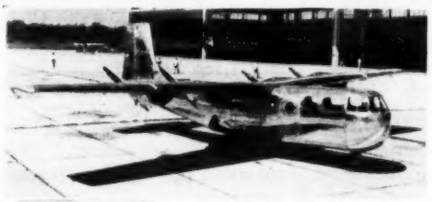
Chase C-122.

● The prototype of the U.S. Air Force's Northrop X-4 experimental high-speed aircraft made its first test flight on December 16th. Power is supplied by two Westinghouse J-30 turbo-jets.

* Excerpts from Nos. 1581-1600 (November 23rd to December 18th, 1948) of "Interavia Air Letter," an aeronautical digest published five times weekly, with photo service, in separate English and French editions.

NEW AIRCRAFT

● The F-86C version of the North American F-86 single-jet fighter has been re-designated F-93A. Extensive engineering changes in the F-86C called for this re-designation.



Monsted-Vincent "Star Flight."

● The "Star Flight," a new four-engined five-seater pusher executive aircraft with two-position propellers, developed by Monsted-Vincent Aeronautical Inc. of New Orleans, La., has a cruising speed of 150 m.p.h., a rate of climb of 1,200 ft./min. and a range of over 1,000 miles. The present 85-H.P. Continental engines are to be replaced with 90-H.P. Continental C90 air-cooled flat-fours.

● The Glenn L. Martin Co. is developing a flying-boat, to be known as the Martin XP6M, which will have a gross weight of 145,000 to 160,000 lbs. It will be powered with propeller-turbines.

● Beech Aircraft Corp. has developed a new primary and basic-advanced military trainer, the Beech 45 "Mentor," which has been undergoing flight tests since the beginning of December. Powered with an 185-H.P. Continental E185 air-cooled flat-six, it grosses 2,650 lbs. and attains a maximum speed of 176 m.p.h. at sea-level. Cruising speed is 160 m.p.h. on 61 per cent. power at 10,000 ft., service ceiling 18,000 ft., and range at cruising speed, 634 miles.

Beech 45 "Mentor."

● The Vickers V-C.2 "Viscount" four-engined airliner has now been cleared for a maximum take-off weight of 45,000 lbs. and for a maximum landing weight of 42,500 lbs. The first prototype, which has been undergoing flight tests since July, 1948, is powered with Rolls-Royce "Dart" propeller-turbines, whose shaft power has been increased to 1,400 H.P. each. The second prototype, now under construction, will be equipped with four Napier "Naiad" turbo-props.

Vickers V.C. 2 "Viscount."

● A. V. Roe & Co., Ltd., is completing the prototype of a long-range patrol bomber, the Avro "Shackleton," which is powered with four Rolls-Royce "Griffon 57" liquid-cooled twelve-cylinder in-line engines of 2,350 H.P. The aircraft will have a gross weight of about 94,000 lbs.

● Five all-cargo versions of the SO 30 P twin-engined transport are at present being built by SNCA du Sud-Ouest at the company's Saint Nazaire plant.

● The SO 6020 single-engined jet fighter prototype, which has successfully accomplished its initial flight, is a single-seater development of the SO 6000 two-seater experimental aircraft. Showing considerable aerodynamic refinement in comparison with the SO 6000, the 6020 is to carry very heavy armament in the fuselage nose. The engine of the new version is a Rolls-Royce/Hispano-Suiza "Nene" turbo-jet of 5,000 lbs. static thrust. Gross weight is about 17,600 lbs and speed is said to be more than 560 m.p.h. at 33,000 ft.

Chance-Vought XF7U-1 "Cutlass" single-seater fighter, powered with two Westinghouse turbo-jets.

● SNCA du Centre is completing the second NC 211 "Cormoran" four-engined cargo transport. Known as the NC 211 No. 1, it is the first production aircraft and has the same power plant as that of the prototype which was destroyed when it crashed last year, namely four SNECMA 14 R air-cooled fourteen-cylinder twin-row radials of 1,600 H.P. The "Cormoran" is to be built in versions with other engines : NC 212 with 2,000-H.P. Bristol "Hercules 738" air-cooled fourteen-cylinder twin-row radials, and NC 213 with 2,100-H.P. Junkers "Jumo 213" liquid-cooled twelve-cylinder in-line engines.

● Société de Construction Aéro-Navale (SCAN), of Port-Neuf, near La Rochelle, is developing a number of new prototype aircraft for the French Naval Air Service : the SCAN 70, a float aircraft for reconnaissance and observation duties ; the SCAN 80, a twin-engined jet fighter with retractable floats ; and the SCAN 72, derived from the SCAN 70 and having a twin fin and rudder unit.

● SNCA du Nord is developing a twin-engined freight transport, the Nord 2500. It features twin tail booms and a central fuselage with a loading door at the rear. Power plant comprises two SNECMA 14 R air-cooled fourteen-cylinder twin-row radials. The prototype is expected to be ready for testing by next April.

● The following prototypes, all powered with one or two Rolls-Royce (Hispano) "Nene" turbo-jets, are expected to make their flight tests during 1949 : SO 4000

twin-engined two-seater bomber ; SE 2410 twin-engined attack fighter ; NC 270 twin-engined experimental aircraft ; NC 1080 single-engined single-seater carrier-borne fighter ; Nord 2200 single-engined carrier-borne fighter ; Arsenal VG 90 single-engined carrier-borne fighter ; Dassault MD 450 "Ouragan" single-engined interceptor fighter; and the Bréguet BR 960 carrier-borne fighter.

SE 2010 airliner accommodating 98 passengers by day and 84 by night. Power is furnished by four 3,550-H.P. Pratt & Whitney R-4360 "Wasp Major" 28-cylinder four-row radials.

● The Avro C-102 four-engined jet-propelled airliner of A.V. Roe (Canada) Ltd. is an all-metal low-wing monoplane designed for use on short- and medium-range routes. Power plant comprises four 3,500-lb.-thrust Rolls-Royce "Derwent V" turbo-jets. Designed to accommodate 40 passengers, if features a span of 98 ft., a length of 82½ ft., a gross weight of 52,500 lbs. and a payload of over 12,500 lbs. Cruising speed is 430 m.p.h. at 35,000 ft.

Avro C-102 four-jet airliner.

● The prototype of the Karku-48 four-seater high-wing monoplane, developed by the Finnish firm of Veljekset Karhumäki O/Y, has been undergoing flight tests since the end of July, 1948, and a second prototype is nearing completion. The aircraft has been tested with both wheel and float undercarriages and, according to a Finnish Civil Air Board announcement, a series of ten aircraft is to be built during 1949 for taxi and charter duties.

INDUSTRIAL NEWS

● The Fairchild C-82 "Packet" twin-engined freighter will be manufactured under licence in Canada, once current negotiations have been concluded. Cancargo Aircraft Manufacturing Co. Ltd. has been mentioned as one of the companies which might undertake C-82 production in Canada.

● The de Havilland D.H. 100 "Vampire" fighters to be produced under licence by SNCA du Sud-Est at Marignane will be equipped, like the "Vampires" manufactured in Australia, with Rolls-Royce "Nene" gas-turbine engines, these being built under licence by Hispano-Suiza.

● The Argentine Government has placed an order for 25 Nord 1200 "Norécrin" four-seater personal aircraft with SNCA du Nord, as a result of recent demonstration flights in South America. Negotiations are also proceeding with the Brazilian Government for the supply of about 100 aircraft of this type.

● Under a four-year plan for the reconstruction of civil aviation, the Italian aircraft industry is to be awarded orders for four-engined long-range transports, twin-engined medium-range transports, light transports, meteorological and survey aircraft, and a large number of air-sea rescue flying-boats. Contracts for engines will include small and large piston engines, and licence-built jet engines. The re-equipment of the civil flying schools will occasion considerable orders for four- and twin-engined types, single-engined primary and advanced trainers, and a fair number of power plants.

AIR TRANSPORTATION

Intercontinental :

● Northwest Airlines opened its service from the Pacific Northwest to Hawaii on December 2nd, eight days after Pan American World Airways started operations over the same route.

● On December 1st Pan American World Airways intensified its all-cargo operations between the U.S.A. and Latin America by putting into service ten Curtiss C-46 "Commando" twin-engined freighters leased from the U.S. Air Force. At the same time PAA inaugurated twice-weekly all-cargo flights between New York and Buenos Aires with Douglas DC-4s.

● Transocean Air Lines is starting a twice-weekly scheduled service between Rome and Caracas, Venezuela.—Air France, on the other hand, intends to operate a Paris—Caracas service via New York from San Juan with Lockheed L-749 "Constellations."

● On December 1st Air France extended its Dakar—Ziguinchor, Senegal, service to Bissao, Portuguese Guinea, via Bathurst in the Gambia. The company is also planning to open a service between Saigon and Noumea in New Caledonia, via Batavia and Brisbane. This route will connect with the Air France Paris—Saigon line, thereby providing a connection from Paris with the French Pacific air services operated by the TRAPAS concern from Noumea.

● British Overseas Airways Corp. and Qantas Empire Airways are to operate jointly an air service connecting Hong Kong with Australia.

● Indicative of the difference in demand between eastbound and westbound trans-Atlantic passenger traffic are British Overseas Airways' trans-Atlantic passenger statistics for the nine months to October 1st, 1948 : 4,464 eastbound and 7,398 westbound passengers.—British South American Airways are intensifying their Nassau—Miami services to a twice daily schedule.

● Since November 16th British Overseas Airways have been flying the Southampton—Johannesburg route three times a week with four-engined Short "Solent" flying-boats.

● K.L.M. Royal Dutch Airlines has extended its South American service from Montevideo to Buenos Aires, as authorised under the recent Dutch-Argentine civil aviation agreement. Douglas DC-6s are used.

Europe :

● On December 15th Sabena introduced a new daily Brussels—London flight, supplementing its present three flights and the two services flown by British European Airways.

● As a result of the transfer of Marrak Airfield, Greenland, from the control of the U.S. Air Force to the Danish Government, the question of a regular air service to Greenland has entered into a topical stage. Scandinavian Airlines System is studying the possibility of operating such a service in cooperation with American Overseas Airlines. It is believed that part of the North Atlantic traffic to Scandinavia might be diverted via Greenland ; on the other hand, a feeder service may be established from Keflavik, Iceland, which has already proved to be an important point on the North Atlantic route. If an air service is finally established, it will assume the character of a line of national importance and will, therefore, be operated by D.D.L. within the framework of Scandinavian Airlines System.

● Polskie Linie Lotnicze (LOT), the Polish airline, inaugurated a twice-weekly Warsaw—Brussels service on December 15th. The route is being flown in pool with Sabena.

Miscellaneous :

● Air France at present uses its various types of aircraft for the following services : Lockheed L-749 "Constellation" : from Paris to Boston and New York, to Buenos Aires, Dakar, Cairo, Rome ; Douglas DC-4 and C-54 : Paris to Saigon, to Tananarivo, Brazzaville, Douala, Lagos, Teheran, Algiers, Casablanca, Nantes—Casablanca ; from Marseilles to Casablanca, from Bordeaux to Casablanca, Lisbon—Casablanca ; from Lyons to Casablanca and to Algiers ; from Tananarivo to Reunion and Mauritius ; from Saigon to Shanghai and to Hong Kong ; Douglas DC-3 : short-stage European routes during the winter months, internal services in French West Africa, Equatorial Africa and Indo-China, and domestic mail services ; SO 161 "Languedoc" : on the major portion of European services and on all services between France and North Africa not operated with DC-4s, as well as on North African internal services ; Consolidated Vultee "Catalina" : local West Indies services and connections between the West Indies and the north of South Africa. AAC-1 : these aircraft, derived from the Junkers Ju 52 and built in France from 1944 to 1946, have been withdrawn from the European and African services (they are among the only types suitable for the internal services in Madagascar); de Havilland "Dragon-Rapide" : internal services in Madagascar.

SERVICE AVIATION

● The Brazilian Air Force is to receive American jet-propelled fighters at the beginning of next year, according to the Air Minister, Brigadier-General Armando Trompowsky. Brazilian pilots are now undergoing training on the new equipment. This is a logical sequel to the recent announcement that the Brazilian Air Force had cancelled its orders for World War II surplus military aircraft. The two jet-propelled fighter types released by the U.S. Government for sale to Latin American countries are the Lockheed F-80 "Shooting Star" and Republic F-84 "Thunderjet". — Following the example of Brazil, the Chilean Air Force is also to purchase a number of jet-propelled American fighters for delivery in 1949. The type of aircraft to be acquired has apparently not yet been determined. The number of machines involved will depend upon the availability of dollar exchange. — Of the three South American countries receiving jet-propelled fighters, only Argentina will operate British equipment (Gloster "Meteors"). However, it is not improbable that the Argentine Air Force will become increasingly dependent on its own constructions, such as the I.Ae. 27 "Pulqui" jet-fighter, developed by the Instituto Aerotecnico de Cordoba.

PHOTO CREDITS :

Front cover : Port of New York Authority ; pp. 71—76 : PAA (3), American Airlines (1), Interavia archives (4) ; pp. 77—78 : Interavia archives ; p. 79 : Interavia archives ; pp. 80—83 : ATP-Bilderdienst, Zurich (5), Clichés Richter, Geneva (1) ; pp. 84—86 : The Glenn L. Martin Co. ; pp. 87—89 : author ; pp. 89—92 : author ; pp. 93—96 : author ; pp. 97—98 : author ; pp. 99—102 : manufacturers ; p. 103 : manufacturers ; pp. 104—107 : author ; pp. 109—110 : Interavia archives ; pp. 112—113 : manufacturers.

Marginal Notes

Collier Trophy, Guggenheim Foundation, and NACA.

Every year in the United States an award is made "for the greatest achievement in aviation in America, the value of which has been demonstrated by actual use during the preceding year." This award, the *Collier Trophy*, established 37 years ago by the first editor of "Collier's Weekly," is highly coveted, having become a sort of Nobel Prize in U.S. aeronautics. The presentation is made annually by the President of the U.S.A.

Today—45 years since the original flight of the Wright Brothers' aeroplane—high-speed flight and research into its problems form the focal point of interest in U.S. aeronautical development. It is therefore not surprising that, on December 17th, 1948, President Truman made the award to three men, who had jointly acquired for America the glory of having been the first to achieve human flight at supersonic speed : *John Stack,* NACA research scientist, "for pioneering research to determine the physical laws affecting supersonic flight and for his conception of transonic research aeroplanes" ; *Laurence D. Bell,* president of Bell Aircraft Corp., "for the design and construction of the special research aeroplane, the X-1" ; and *Captain Charles E. Yeager,* U.S. Air Force, "who, with that aeroplane, on October 14th, 1947, first achieved human flight faster than sound."

Not only the Collier Trophy citations reveal the path being taken by U.S. aeronautical research and which domains are considered to be the most important for the next few years ahead. At almost the same time, it was announced that the *Guggenheim Foundation* had underwritten, for a period of seven years, two new research centres and appropriated half a million dollars for that purpose.

To be known as the Daniel and Florence Guggenheim centres, they will be located at Princeton University in the east and California Institute of Technology in the west. Offering facilities for education and research in jet propulsion and rocket engineering, they will emphasise "particularly the development of peace-time uses of rockets and jet propulsion."

That the U.S.A. puts supersonics, guided missiles and atomic research well at the top of its development programme is also evident from a statement by John F. Victory, Executive Secretary of the *National Advisory Committee for Aeronautics.* He maintains that supersonic speed will face no upper limit once the problem of cooling the outer services of fast-flying bodies has been solved. As for America's advance in these domains, he says that not only did NACA believe the Russians do not have the atomic bomb, but would not believe, either, that they would pierce the sonic barrier with manned aircraft. Stemming from a NACA spokesman, this statement may be noted as a fitting reply to a number of contrary reports issued by the Soviet press.

Malaise in France.

The inauguration of the Paris Salon de l'Aéronautique lies scarcely three months ahead.

In theory, the eighteenth Salon should have taken place last year. However, the exhibition committee considered it wiser to postpone the opening. In the autumn of 1948 the U.S. aircraft industry, and thus indirectly the world's aircraft industry, was facing the setbacks of war-peace conversion. The French aircraft industry ? It was only too glad to see the Salon postponed, hoping that this would allow further time for developing, to the point of proven practical utility, the many projects exhibited in 1946.

Despite this, it will be no easy matter for the French industry to fulfil its 1946 promises at this year's Salon. We only need point out two of their attractions at the last show : the NC "Cormoran" four-engined freighter and the SO 6000 two-seater jet trainer. The first-mentioned aircraft was completely destroyed in a crash, and the second one suffers from engine and undercarriage troubles, which have hitherto delayed its delivery.

It would be altogether too simple to attribute the present shortcomings of the French aircraft and engine manufacturers to nationalisation. True, in a number of cases business favouritism, inefficiency and political manœuvres have brought firms to the brink of disaster—if one can at all refer to the brink of disaster in connection with nationalised trade. But the real reasons lie deeper.

The general political situation in Europe, which nowadays is resorted to as a means of clarifying or excusing all things, reveals its influence here, too. At the time these lines are being written, a new French financial and commercial programme is being debated. The French Government stands on difficult but not hopeless ground. There is no doubt that the treaty discussions with Washington and London contain possibilities for improving the situation. But not until there is a coordination of plans for finance and commerce, of Defence Ministry and General Staff, will French industry, particularly the suffering aircraft industry, obtain what it needs most of all : *A Programme.*

How can the industry be placed on a healthier basis if the minimum five-year period required for developing an aircraft is each year overshadowed with doubts because of an acceptance or rejection of the Budget, or the political and personal influences of the everchanging Government members ? How can an industry ever find peace if contracts are constantly being modified, annulled, postponed or cut ?

Since the Government demanded official reports on the French aircraft industry a year ago, much has been written on this subject in France, and not always from an objective standpoint. However, we would like to bring to notice one exception. Around the middle of last December, the Paris daily paper *Le Monde* published an expertly-written article signed C. Aubert. The writer came to the following true conclusion :

> "... *France has an aviation budget, but no aviation policy. Worse still : it cannot have one today. Technically, socially and politically, the drama of French aviation has become an international question.*"

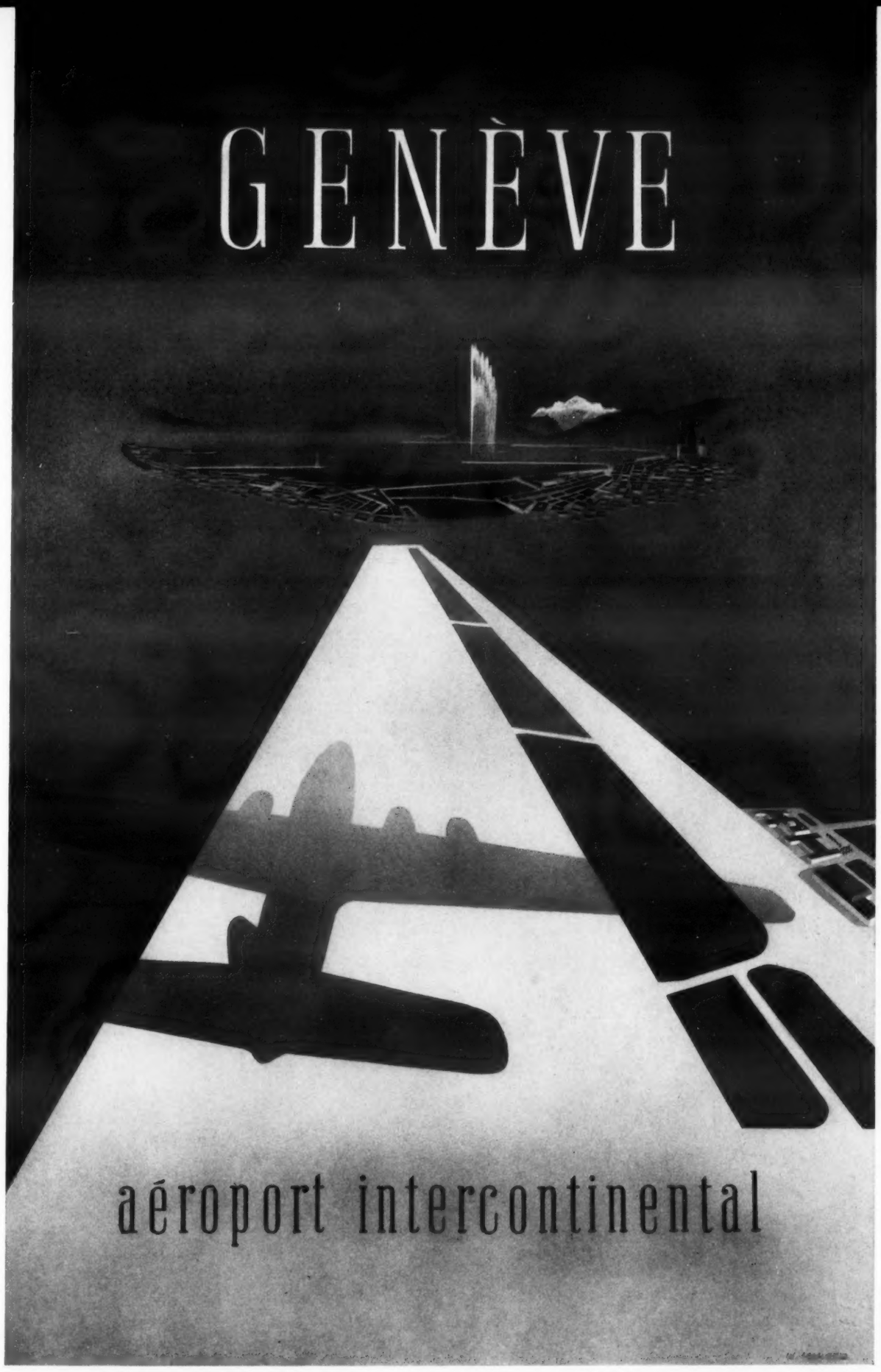
This question, too, will now have to be clarified.

The New Size

In compliance with numerous readers' desires and suggestions, this magazine has been given a new size, beginning with the first number of Vol. IV, which we hope will meet with the approval of all.

Superior paper and printing method, and, naturally, continual improvement in the contents, will prove to readers that we wish to keep on the move and are unchangedly working to perfect our magazine.

The Editors.



Flying to Geneva gives you longer winter sports holidays!

A MAN TO BE RELIED ON

With over 40 years of experience in the aviation field, Esso provides great airlines and private owners alike with products and service of the same high quality. Esso service men are first of all capable and intelligent. They are carefully trained to do their important jobs thoroughly — dependably.

Fliers along the airways of the world look to the Esso winged oval as the symbol of this carefully planned service as well as of the uniform, quality products on which they can always rely.

The 60-page Esso Refueling Guide shown below is typical of the thorough-going methods which help to maintain Esso standards of service at the Esso winged oval sign. The manual provides Esso aviation servicing personnel with exact directions — in clear text and diagram — for handling Esso Aviation Products, for fueling procedures and for insuring safety.

ESSO AVIATION PRODUCTS

ESSO EXPORT CORPORATION, AVIATION DEPARTMENT · 25 BROAD STREET, NEW YORK 4, N. Y.